Open Source Seismic Visualization Package on OpenNebula Cloud Management System

by

Nur Fairuz Izzati Binti Mohd Zain

13572

Dissertation submitted in partial fulfilment of

the requirements for the

Bachelor of Engineering (Hons)

Petroleum Engineering

MAY 2014

Universiti Teknologi PETRONAS

Bandar Seri Iskandar

31750 Tronoh

Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

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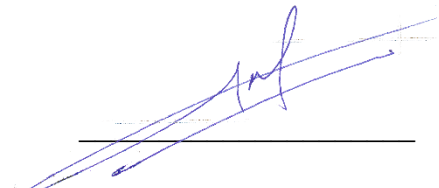


(Dr. Izzatdin Abdul Aziz)

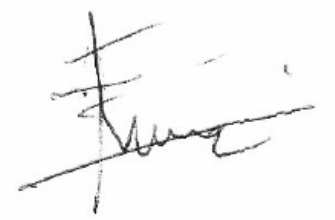
UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

May 2014

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.



NUR FAIRUZ IZZATI BINTI MOHD ZAIN

ABSTRACT

Currently, the exploration of oil and gas have become more complex due to the oil depletion. The increasing difficulties in discovering new hydrocarbon reservoirs using existing technologies have caused an exceptional rise in the cost and risk to discover hydrocarbons. Seismic interpretation is one of the main element in oil exploration. Seismic interpretation software is vital to assist geophysicists to find hydrocarbons trap. However, specialized commercial seismic visualization package is highly priced. Hence, open source seismic visualization package is introduced as an alternative to minimize the cost in oil exploration. The goal of this research is to demonstrate through comparative study of computing functionalities between two different types of open source seismic visualization packages in order to find a preferable one to integrate in cloud infrastructure, OpenNebula cloud. This paper addresses how the author chooses OpendTect over ParaViewGeo as the preferable open source seismic visualization packages by comparing the functionality of the software packages. In addition, a research study on OpenNebula also has been done to understand the working principle of this cloud management system. Furthermore, an experiment has been conducted to test whether or not the preferable open source seismic visualization package is able to be integrated correctly in OpenNebula cloud with high scalability and good performance.

ACKNOWLEDGEMENT

With this precious opportunity, I would like to first extend my heartiest gratitude to Allah SWT, the most gracious for giving me the opportunity to experience these 11 very useful weeks with the people who have helped and supported me throughout this final year project.

First and foremost, I would like to extend my deeply sincere gratitude to my supervisor, Dr. Izzatdin Bin Abdul Aziz, for the endless support and guide me patiently on all my tasks, and also exposed me with so much information regarding the IT involvement in the industry of oil and gas. I am very grateful to him for his comments and suggestions for improvements. This project is much improved through his contribution. It would be impossible for me to complete Final Year Project without his help, cooperation, support, and guidance, understanding and non-stop commitment towards organizing such a program.

I would also like to extend my appreciation to Mr. Fazli Ahmat Jalaluddin from Research Department for supervising me and giving me such great help throughout this project. The exposure to the OpenNebula cloud management system truly helped the progression and smoothness of the project completion.

My acknowledgements would be incomplete without giving credits to the Final Year Project coordinators from Petroleum Engineering Department for their hard work in organizing the final year students throughout completing our final year project.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

UTP	Universiti Teknologi Petronas
SVP	Seismic Visualization Package
CMS	Cloud Management System
HPC	High Performance Center
VM	Virtual Machine
CPU	Central Processing Unit

CHAPTER 1

INRODUCTION

1.1 Background Study

The scarce existence of hydrocarbon resources have made it more difficult for oil and gas companies to discover new reservoirs using existing technologies. The increasing difficulties in discovering new hydrocarbon reservoirs using existing technologies have caused an exceptional rise in the cost and risk to discover hydrocarbons. A significant way to reduce discovery cost is through the use of a less expensive seismic visualization package (SVP). Although large companies are able to pay for the expensive commercial seismic interpretation software in the oil and gas exploration, it is wise to search for a new alternative to minimize the exploration cost. The alternative way to reduce the seismic interpretation costs is by using economical open source software. Now, the open source software is slowly gaining more attention in the oil and gas industries and one of the software is OpendTect.

OpendTect is one of the open source SVP that is use for processing, visualizing and interpreting large size seismic data that can be downloaded directly from the Internet, allowing users to use it immediately. It is a software tool that is capable of delivering fast-track development of innovative interpretation of seismic dataset. A natural way to process large scale data at a higher speed and performance is through the use of distributed systems such as on High Performance Computing (HPC) system and cloud. However, some geologists questioned about the ability of open source SVP whether or not it able to function correctly on distributed system such as on cloud based systems.

The main goal in this research is to prove, by using a comparative analysis of computing functionalities between open source SVPs that are available on the internet. This research is also to demonstrate the concept installation and to prove execution of open source SVP on cloud management system. The subject of our study is OpendTect. It is a seismic visualization package, in which its popularity is gaining momentum amongst geophysicists in the scientific and industrial community as well as many universities worldwide. Meanwhile, the subject for cloud management system is OpenNebula cloud.

1.2 Problem Statement

1.2.1 Problem Identification

Currently, in oil and gas industries, geologists as well as students from universities have been using specialized commercial software to perform SVP. Specialized commercial software packages are very expensive [7]. Therefore, in order to reduce the cost, open source SVP is introduced as an alternative method to assist geologist in the search of hydrocarbons and also to assist petroleum students in the education of oil and gas.

However, some large companies in oil and gas industries are not interested and less confidence in the application of open source SVP as a cheaper alternative for this industry. This is due to the bad perception of open source software that they are just a packages of seismic functions without appropriate function integration and support as expected in commercial software packages [7].

A part from that, in order to reduce the installation cost of the seismic software, this project suggested a natural way to process large scale seismic data at a higher speed and performance through the use of distributed systems such as on High Performance Computing system and cloud based systems.. This triggers another question, whether or not open source SVP such as OpendTect is able to function and perform correctly on cloud based systems, in particularly open source cloud management system (CMS), such as OpenNebula cloud.

1.2.2 Significance of the Project

The development of this project will be beneficial in order to help geophysicists and also petroleum students in university to see the ability of open source SVP to be execute in industrial scale of seismic data interpretation by using features and functions provided by the open source packages itself on OpenNebula CMS.

1.3 Objectives

This project focus on the open source SVP. The main objectives of this project are listed below:

- *To conduct a comparative study on two different open source seismic visualization packages.*

  In order to achieve this objective, studies of features and functionality of open source SVP: OpendTect and ParaViewGeo have been conducted. The study involved analysing articles, web reviews, and available software manual.

- *To conduct a study on the preferable open source seismic visualization package to be executed on OpenNebula cloud management system.*

  Based on the findings from the first objective, an analysis of the preferable open source software is performed on the OpenNebula cloud management system.

- *To investigate whether the open source seismic visualization package is able to be executed on the OpenNebula Cloud with high scalability and good performance.*

  Based on the different virtual machines configuration created on OpenNebula cloud, experiment is setup in order to test the performance of execution time of open source SVP when executed on the virtual machine.

1.4 Scope of Study

The scope of study focuses towards execute of open source seismic interpretation and visualization package on OpenNebula clouds management system. The basic tools for the overall development are as follows:

- OpenNebula as the cloud platforms.
- OpendTect 4.6.0 as the open source seismic visualization package.
- TeamViewer 9 as the application of remote control.
- Windows 7 as the operating system.
- Dip steered median filter as the seismic attribute.

CHAPTER 2

LITERATURE REVIEW

2.1 Cloud Computing

Cloud computing and open source software share a common connection where open source provides an essential foundation for cloud computing. The mutually beneficial relationship between these two technologies has helped to transform the technology into more advance industry and increase the marketplace. Today, cloud computing has still not aggressively entered the oil and gas industry. However, there are a few of the companies in the beginning stages of implementing cloud computing.

Most popular definitions of cloud computing reference to a kind of computing system that depend on sharing computing resources rather than having the resources on every personal devices or local servers to handle applications. The following are two examples of such definitions:

> *Cloud computing refers to computing power in an imaginary bubble which is called a cloud and allows users to access software, applications, and data from a common location and this service is shared by multiple users within a secure or open environment [Smich, 2010]*

> *Instead of installing a suite of software for each computer, you'd only have to load one application. That application would allow workers to log in into a Web-based service which hosts all the programs the user would need for his or her job. Remote machine owned by another company would run everything from e-mail to word processing to complex data analysis program. It's called cloud computing. [Strickland, 2008]*

In term of data sharing, cloud offers more benefits which provide many options for the computer user as well as large and small businesses. These days, the major concern in organizations is to reduce the cost expenses. Therefore, the cloud model offers the promise of massive cost saving in organizations due to the cheaper hardware costs but in term of physical resources, it is more effective to use. Thus, it provides great potential to be greener and more economical. Another good thing about clouds is that, it is universal access which allow users to access applications and services remotely via the internet. Therefore, with a great flexibility, it allows users to change applications easily and quickly with demands and fast implementation time [1].

2.2 OpenNebula

***Figure 1**: OpenNebula Interface*

There are several fundamental models in cloud services which are infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS). Our main focus in this project is IaaS. As shown in figure 1 above, one of the IaaS in cloud computing is OpenNebula. It is a virtual machine that offer cloud interface for disclosing its functionality for network management and storage.

A virtual machine is a software computer that provides user to run operating system and application like a physical computer. There are many reasons for focusing on OpenNebula in this project. It is an open source CMS with free marketing that includes all main functionalities for cloud computing with a single installing, patching and updating process [4]. In a simple word, OpenNebula delivers availability, reliability, scalability, security and efficiency. However, it has found that, little has been done in the use of OpenNebula in oil and gas industry specifically in supporting geologist to interpret and visualize the seismic models. Figure below represent how the virtual machine should look like in OpenNebula CMS.

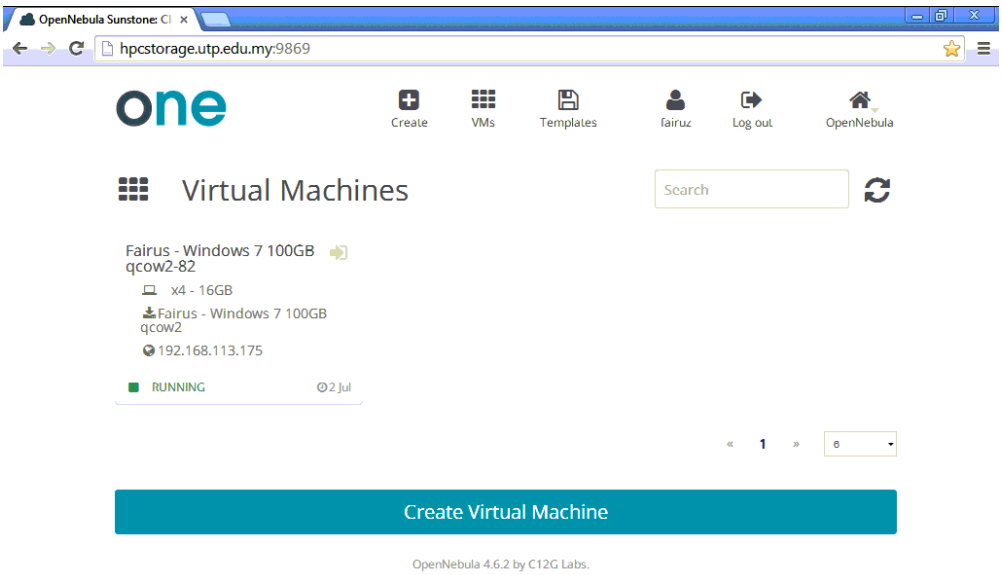


Figure 2: *Virtual Machine with OpenNebula*

2.3 Open Source Seismic Visualization Packages

The beginning of hydrocarbon exploration starts with geological exploration process followed by seismic data processing and interpretation. Subsurface geological formation can be very complex at certain area. Due to that, misinterpretation of seismic data may occur. In order to assist geologist in predicting hydrocarbon traps in very complex geological subsurface, output from seismic data processing packages are feed into seismic interpretation and visualization.

Open source is a new technology widely used in recent years as it allow any user to freely use, modify, and redistribute the original software [6]. Open source SVP offers cheaper alternative for seismic interpretation processing hence reduced the computing and software cost that used in the exploration of hydrocarbons. As compared to commercial software packages, the open source SVP also provide same features and functionality in seismic computational, which are consistently being enhanced and improved by the geophysical community [7].

2.4 OpendTect

For this project, OpendTect is used as an open source seismic data interpretation and visualization package as it is slowly gaining a foothold in the oil and gas industry. This software can be downloaded at no cost and enables users to process, visualize and interpret multi-volume seismic data using attributes and modern visualization techniques [10]. OpendTect users can develop their own interpretation tools as plugins to the system. Another benefit of OpendTect, it supports seismic computational function from other seismic data processing package such as Madagascar [5].

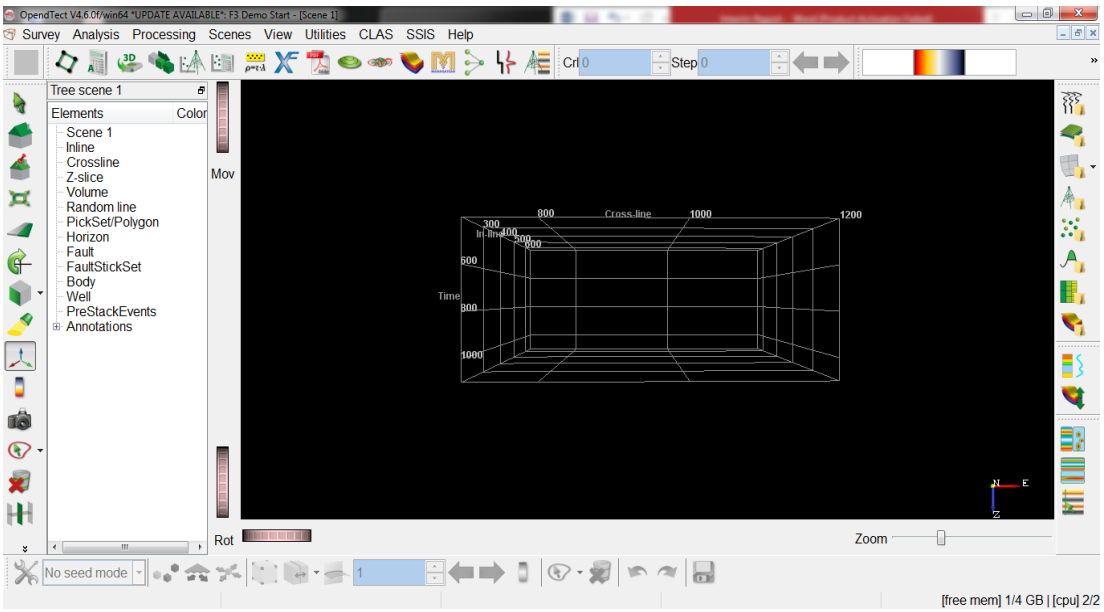


Figure 3: *The Features in OpendTect*

2.5 Functionality Requirement in Open Source SVP

There are many open source SVP that are available for geophysical data interpretation and visualization packages in hydrocarbon exploration. Table 1 shows the comparative analysis between two difference types of open source SVP. The comparative analysis focuses on the computational function of each software packages.

Functional Requirement		Description
Multiple Platform	Windows	Enable users, administrator, to use the product in any platforms that the product can be implemented on.
	Linux	
	Mac OS X	
Language	C++	Enable developer to work on the product without considering the type of platform it being implemented on.
	Phyton	
License	GPL	Enable users to give permission to fully access the packages and optionally extended with commercial plugins.
	Commercial	
	Academic	
Visualization	2D Interpretation	Enable users to work in any visualization that the product can be interpret.
	3D Interpretation	
Interface support	Petrel	Enable product to integrate with the existing applications and databases.
	Madagascar	
	GMT	
Seismic Plugins		Enables users to work with variety features of seismic attribute and filters for typical geology & geophysics tasks.
GUI Interface		Provide user an interface to interact with the system.
Flexible Cost		The product plugins' price is reasonable.

Release Independent	Ensure that the new version of the product can be integrated with the old version or able to work independent without being uninstalled and install every time a new version release.
Memory RAM	Allow data items to be read and written in roughly the same amount of time regardless of the order in which data items are accessed.
Free Hard Disk Space	Enable users to storing and retrieving data items in any order.

Table 1: *Functional Requirements for Open Source SVP*

CHAPTER 3

METHODOLOGY

3.1 Procedure Identification

The method used in order to complete this research project is Hypothetico-Deductive Method as it serves as the typical method in a research field. The approach in used to perform this project is illustrated as in *Figure 1* below.

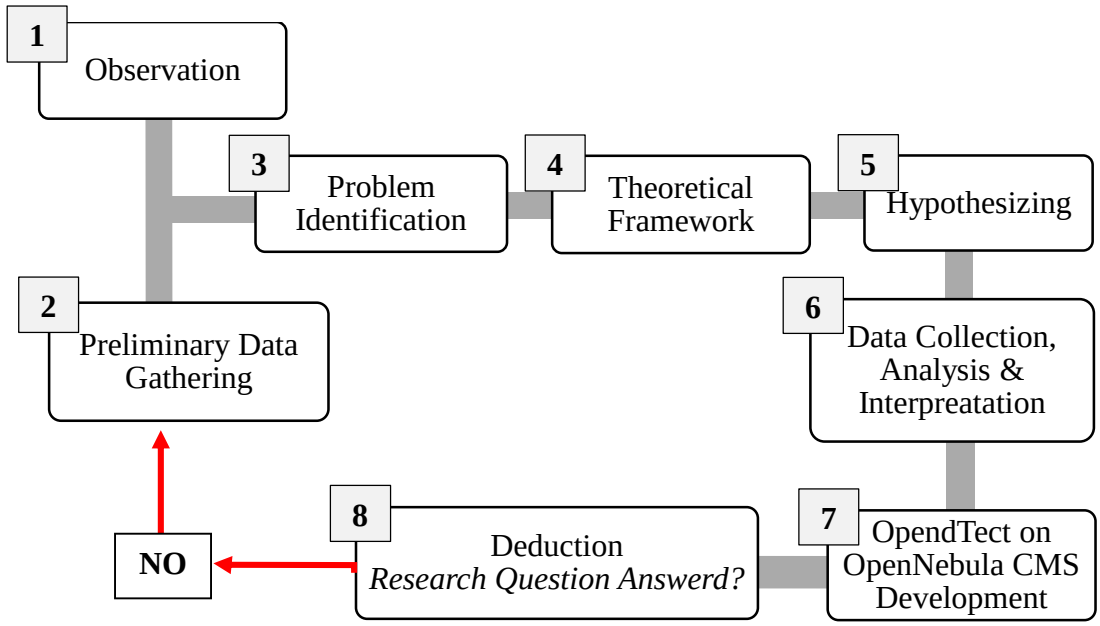


Figure 4: *Research Method and System Development Lifecycle for Open Source SVP on OpenNebula CMS.*

3.1.1 Observation

Observation method is carried out by observing the list of open source software for seismic visualization, interpretation and analysis packages that are available in the internet. During this stage, comparative study between packages are initiated depending on its scope of functionality. The case history of open source seismic visualization packages on cloud based system is also being observed.

3.1.2 Preliminary Data Gathering

This stage involves in search of information in depth of what being observed earlier. This is done by performing searches in web, article and previous research papers. The main focuses are on the study of open source SVP in relation to OpenNebula CMS. However, since this relationship are still new and have not yet attract the attention from community, most information are obtained from the Internet and only few are from articles.

3.1.3 Problem Identification

This is where the problem is defined and narrowed to ease the study. Unnecessary elements that could make the problem unclear are filtered and eliminated, thus simplifies the problem. Hence, it would make it clear to seek for solution.

Based on the observation and preliminary data gathering phase, there are many uncertainties found in the application of open source SVP on OpenNebula CMS, such as system performances and difficult for user to execute instruction as this product never been execute on OpenNebula CMS. The interaction between open source SVP and OpenNebula CMS are being focus in this study as they are the main element of this research project. Therefore, these problems are narrowed down, by filtering other problems that are considered as out of job scope and less important for open source SVP standards.

3.1.4 Theoretical Framework

From the observation, data gathering and also conceptualized problem, theories are formulated. The theory in figure 2 shows that the relationship of using open source SVP on OpenNebula CMS can provide effective way to minimize cost installation of hardware in organization and also allow users to access the application remotely via the internet on users' personal devices.

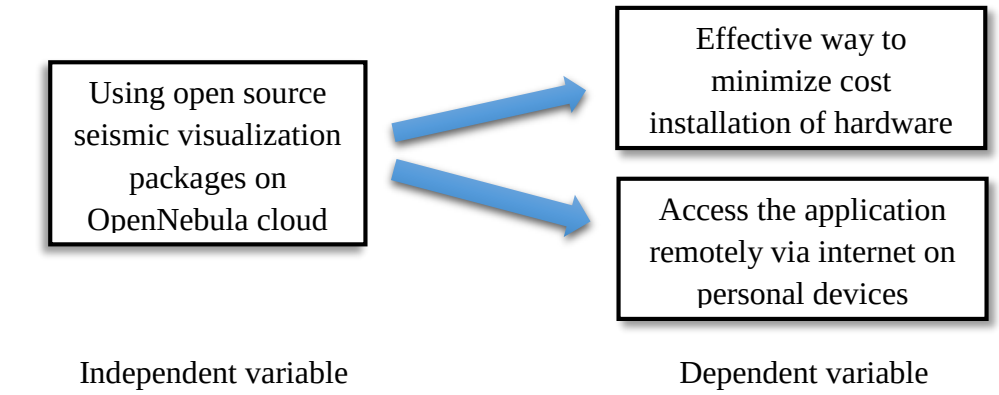


***Figure 5**: Diagram on Relationship between Independent and Dependent Variable*

3.1.5 Hypothesizing

Referring to the theoretical framework, there are two hypotheses that can be derived.

- *The Null Hypothesis, H_o*

  H_o: Open source SVP cannot be execute on OpenNebula CMS.

- *The Alternate Hypothesis, H_A*

  H_A: Open source SVP can be execute on OpenNebula CMS.

3.1.6 Data Analysis

At this stage, the open source SVP is executed in the virtual machine created in the OpenNebula CMS by using remote control software called TeamViewer. This is a software for remote control, desktop sharing and file transfer between computers. After connected to the virtual machine, the features, functionality and attributes of the open source SVP are being analyzed.

3.1.7 Open Source SVP on OpenNebula CMS Development

After having proven that the open source SVP can be executed on OpenNebula CMS, then the next step is to create a new seismic survey or setup a sample survey based on the guideline. This would then reconfirm the result of the research conducted, as the outcome of the product will once again evaluated.

3.1.8 Deduction

This is a process of interpreting the data analysis results as a conclusion. This phase will determined whether the open source SVP can really be execute on OpenNebula CMS and the guideline can be apply.

3.2 Project Activities

The following activities have been set in order to achieve all the project objectives:

PHASES	ACTIVITIES
Planning	1. Perform a comparative study between open sources SVP. 2. Identified the preferable open source SVP. 3. Study the architecture of OpenNebula CMS in order to integrate with the proposed open source SVP. 4. Create a virtual machine in OpenNebula CMS. 5. Install TeamViewer as a tool for remote control to connect to virtual machine. 6. Install the preferable open source SVP in virtual machine.

Implementation	1. Integrate OpendTect in OpenNebula CMS. 2. Perform seismic survey.
Analysis	1. Analyze using free seismic survey. 2. Determine location and position of the seismic data. 3. Determine types of features and functionality available. 4. Analyze types of seismic attributes. 5. Analyze the performance loading speed.

Table 2: *Phases Involved in Open Source SVP on OpenNebula CMS Development*

3.3 Tools Required

To ensure the success in developing this research project, the development tools and other assisting equipment are listed in the following table. Refer table 3 below.

Hardware	Software
▪ ASUS*Tek* ▪ Intel Pentium ▪ CPU B950 2.10GHz ▪ 4.00 GB RAM ▪ 64-bit OS ▪ 500 GB HD space	▪ OpendTect 4.60 ▪ ParaViewGo ▪ OpenNebula Sunstone ▪ TeamViewer 9 ▪ Snipping Tool ▪ Windows 7

Table 3: *Tools Required in Application Research and Development*

3.4 Key Milestone

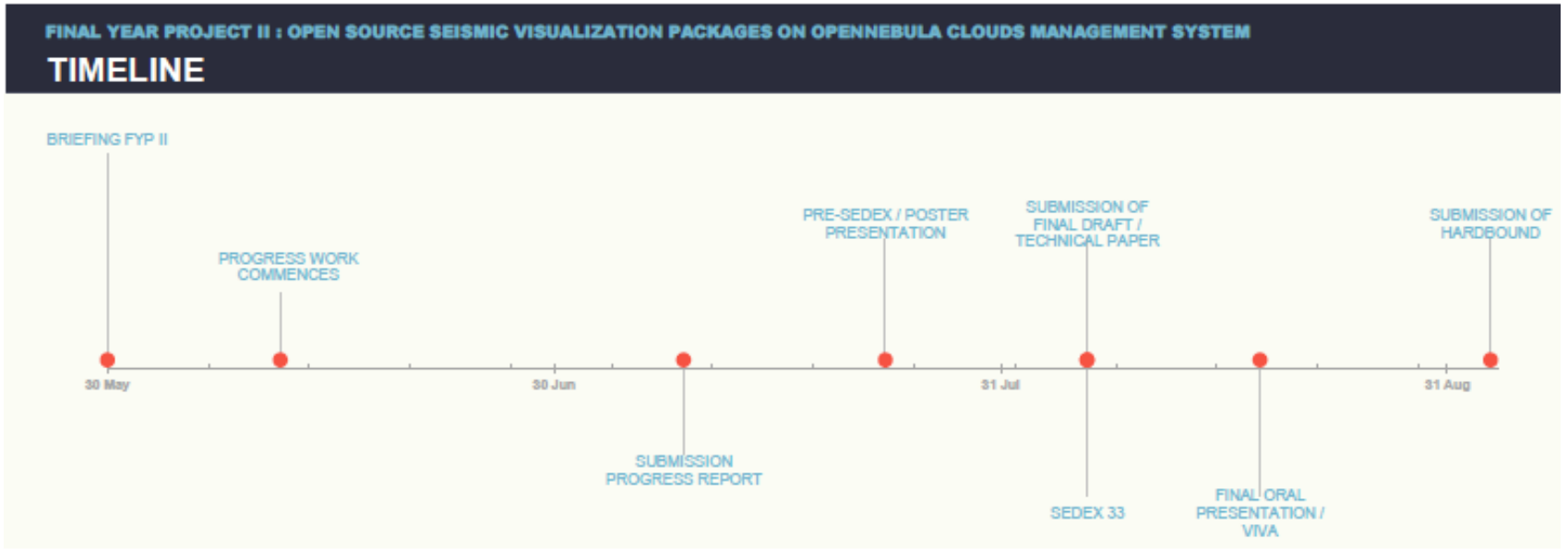


Figure 6: *Research Key Milestone*

The key milestone shows the schedule event signifying the completion of Final Year Project II that mark important dates in the process. It starts with receiving some updates on student progress during briefing FYP II. Followed by commencing progress work and submitting the progress report. Poster presentation will be conducted after done with progress work. After the poster presentation, is the submission of the final draft report and followed by the technical paper. Finally, a final oral presentation or viva will take place and complete the final year project with submission of hardbound copies.

Figure 7: *The Key Milestone of Project Activities*

3.5 Gantt Chart

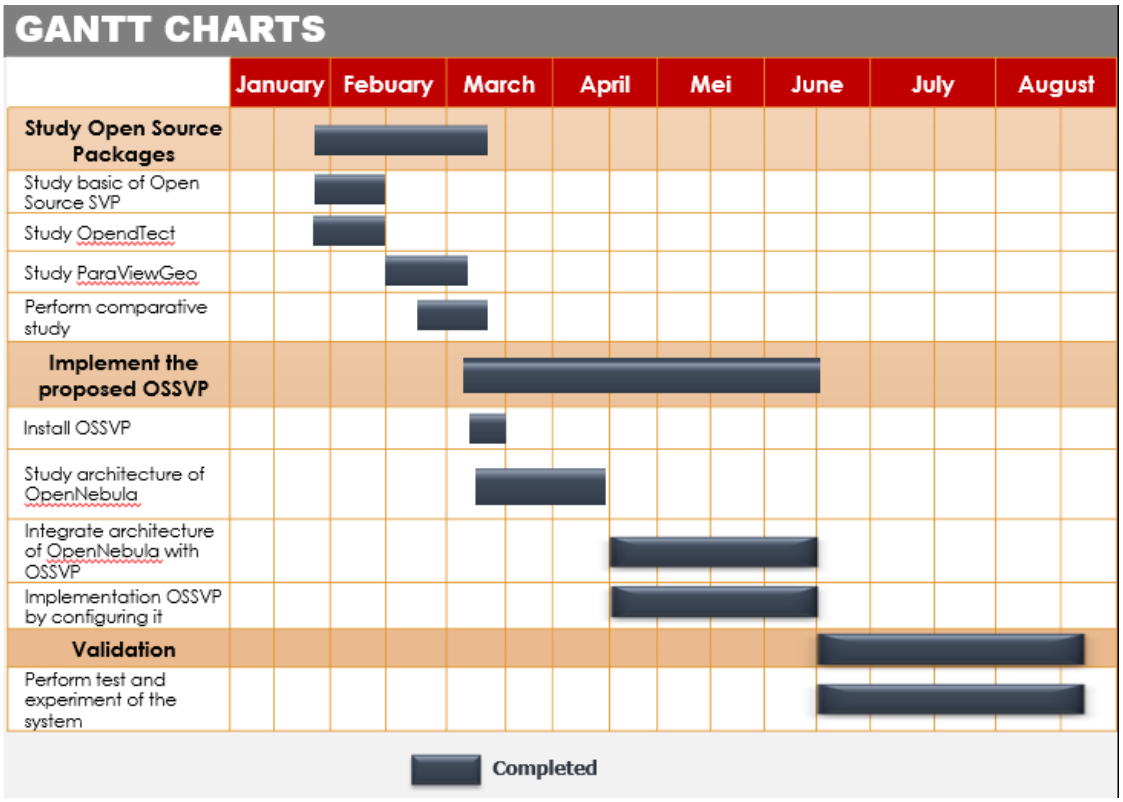


Figure 8: *Research Gantt chart*

CHAPTER 4

RESULT AND DISCCUSSION

4.1 Research Findings and Results

4.1.1 Comparative Study

First comparative study was about to narrowed down and choose two open source SVP that will be used for next comparative study. The comparison is based on the list of seismic visualization, interpretation and analysis packages that are available on the internet. The comparison is done by research on the purpose use of the software and its scope of functionality for this project. The list of packages can be seen below:

NAME	DESCRIPTION	ORIGINATOR
OpendTect	Geoscience interpretation and visualization	Dgb Earth Sciences
GeoTriple for Oil & Gas Exploration	Geoscience data management, display and analysis	Geoforge project
GeoCraft	Geophysical analysis and visualization	ConocoPhilips
qiWorkBench	Geophysical interpretation and visualization	BHP Billiton Petroleum
Generic Mapping Tools	Map generation and analysis	Lamont-Doherty and University of Hawaii
ParaViewGeo	Geoscience extension of ParaView	Kitware ParaView, MIRARCO

Table 4: *The List of Open Source Seismic Visualization Packages*

Second comparative study was about to choose between two types of open source software to be implemented in this project. Two types of open source SVP were chosen to make comparisons which are OpendTect and ParaViewGeo. The comparison can be seen from Table 2 below.

Functional Requirement		OpendTect	ParaViewGeo
Platform	Windows	**YES**	**YES**
	Linux	**YES**	**YES**
	Mac OS X	**YES**	**NO**
Language	C++	**YES**	**YES**
	Phyton	**NO**	**YES**
License	GPL	**YES**	**NO**
	Commercial	**YES**	**YES**
	Academic	**YES**	**NO**
Visualization	2D Interpretation	**YES**	**YES**
	3D Interpretation	**YES**	**YES**
Interface support	Petrel	**YES**	**NO**
	Madagascar	**YES**	**NO**
	GMT	**YES**	**NO**
Seismic Attributes		**MORE**	**LESS**
GUI Interface		**PROVIDED**	**PROVIDED**
Flexible Cost		**Open Source** – It provides product for downloading only.	**Fully Open Source** – It provides product, and code for downloading.

Release Independent	**YES** – The latest version is OpendTect 4.6 which is fully backward compatible with the previous version.	**MAYBE** – The latest version is ParaViewGeo 1.4.13. Older version may not contain all the functionality mentioned herein.
Memory RAM	**>2 GB**	**>2 GB**
Free Hard Disk Space	**>200 MB**	**>300 MB**

Table 5: *The Comparative Study on Open Source SVP*

Based on the comparison between these two open sources SVP, one of the obvious differences that has to be mentioned here is that ParaViewGeo provide less seismic attribute and filters features while OpendTect provide more details on that. After looking from the comparative study table, OpendTect possesses more functionality remarked. Therefore, OpendTect is the proposed Open Source SVP of this project.

4.1.2 Flow Chart Diagram

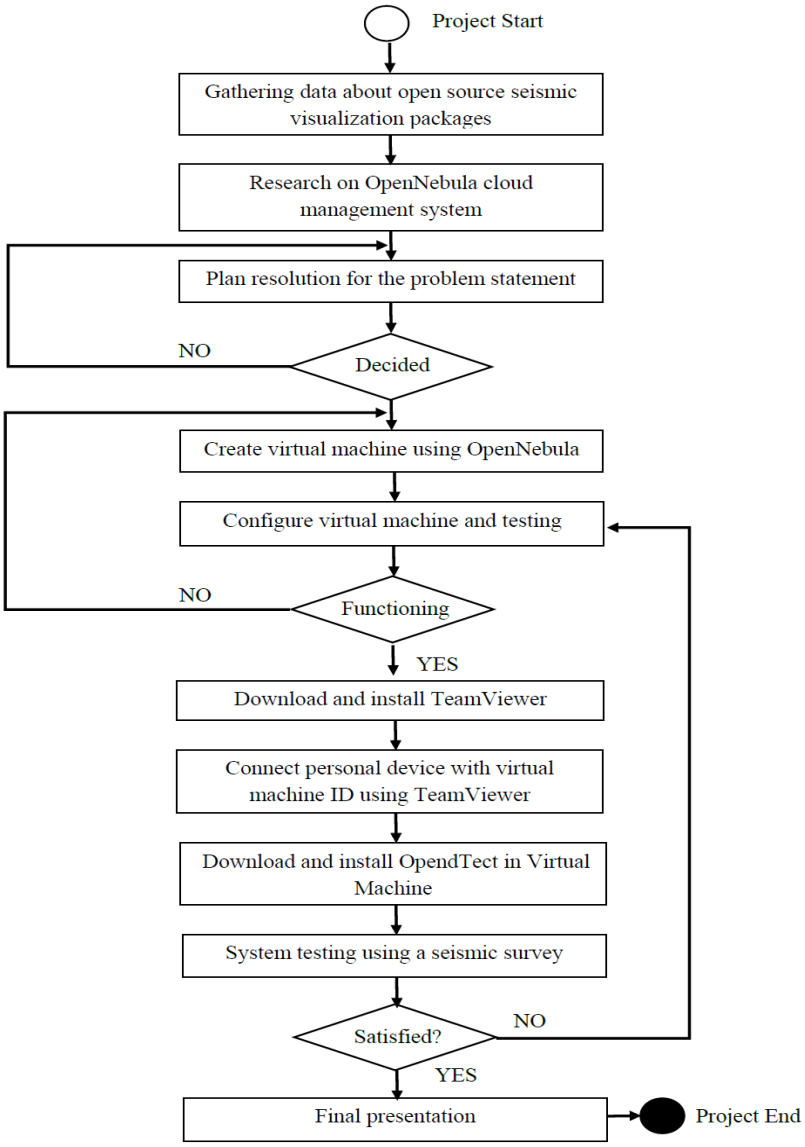


Figure 9: *Flow Chart Diagram for Whole Development of the System*

The flow chart diagram above shows the whole process of development of this project. In order to complete a successful system, the development of this research project must be follow stage by stage. Every stages must be achieved and satisfied to proceed to another stage or else the tasks in the early stages need to be revised.

4.1.3 System Architecture

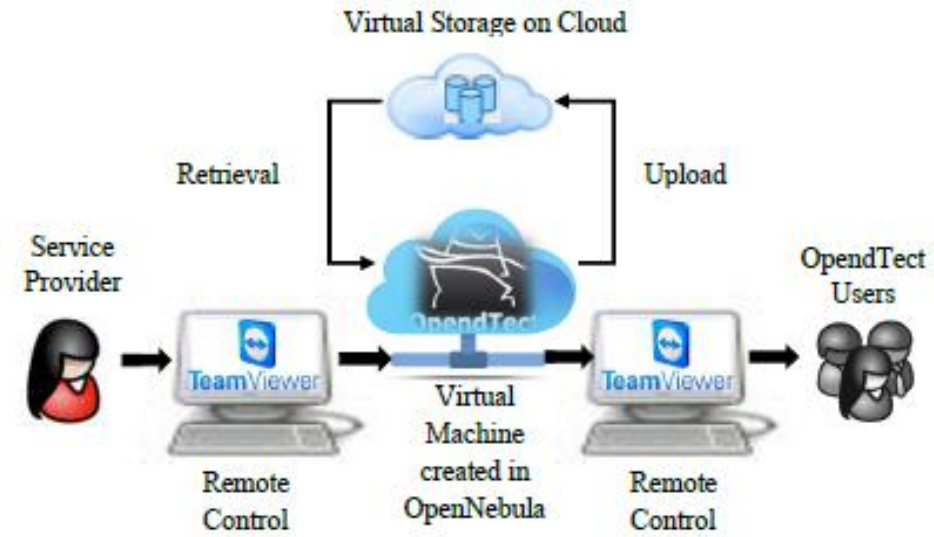
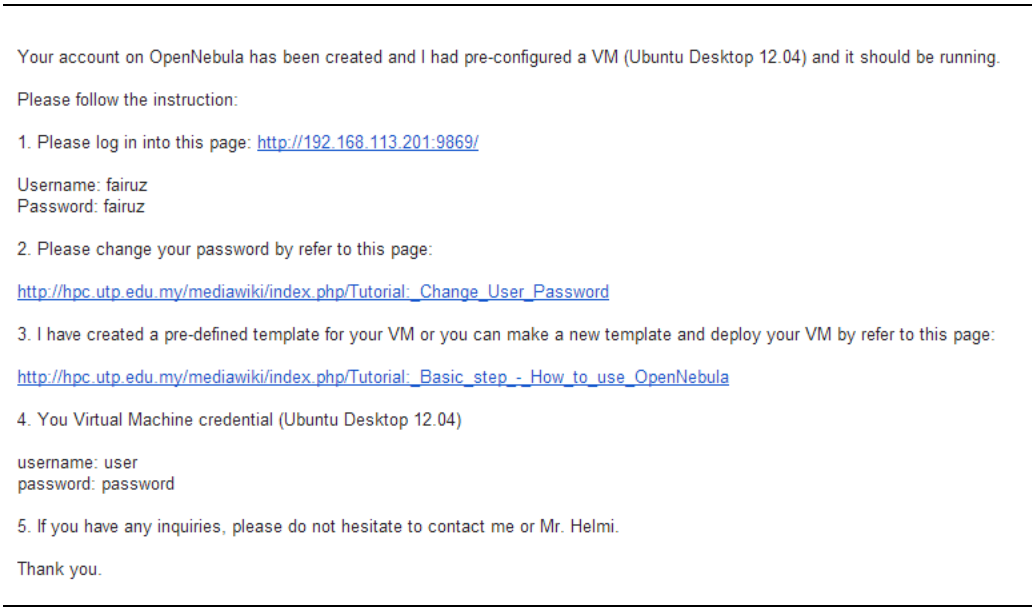


Figure 10: *System Architecture for Open Source SVP on OpenNebula CMS using TeamViewer*

Figure system architecture above illustrate the whole operation of the system. Starting with service provider by creating a virtual machine on OpenNebula cloud. Once the service provider managed to create the virtual machines, the TeamViewer software and the preferable open source seismic visualization packages are installed in the virtual machine. The virtual machine can be access by using TeamViewer. TeamViewer is an open source software that lets the user to fully control of another computer from their own computer as long as both machines are running TeamViewer. In this project, TeamViewer enables two-way connections in which the user can get control of the virtual machine just as if the user were sitting in front of the virtual machine.

When using TeamViewer, the virtual machine's ID and password are needed when log on in order to control and transferring the seismic data files from user's personal device to the virtual machine. At this point, the users are able to use OpendTect which is the preferable open source seismic visualization package and start a seismic survey by using the transferred seismic data files.

4.1.4 System Interface of OpenNebula


Your account on OpenNebula has been created and I had pre-configured a VM (Ubuntu Desktop 12.04) and it should be running.

Please follow the instruction:

1. Please log in into this page: http://192.168.113.201:9869/

Username: fairuz
Password: fairuz

2. Please change your password by refer to this page:

http://hpc.utp.edu.my/mediawiki/index.php/Tutorial:_Change_User_Password

3. I have created a pre-defined template for your VM or you can make a new template and deploy your VM by refer to this page:

http://hpc.utp.edu.my/mediawiki/index.php/Tutorial:_Basic_step_-_How_to_use_OpenNebula

4. You Virtual Machine credential (Ubuntu Desktop 12.04)

username: user
password: password

5. If you have any inquiries, please do not hesitate to contact me or Mr. Helmi.

Thank you.

Figure 11: *Creating Account on OpenNebula*

Figure above shows the first step of this project by creating an account on OpenNebula in order to configure a virtual machine (VM). Mr. Fazli from UTP HPC centre has helped author to create an account on OpenNebula and pre-configured a VM. There are different user types in the OpenNebula system:

- **Administrators (Mr. Fazli)**, the *oneadmin* account is created the first time OpenNebula is started. The *oneadmin* has enough privileges to perform any operation on any object in OpenNebula CMS. User account within the OpenNebula system are managed by *oneadmin*.

- **Regular user (Author)** accounts may access most of the functionality offered by OpenNebula to manage resources. Each user has their own username and password to connect to OpenNebula, and belongs to a group. A group in OpenNebula makes possible to isolate users and resources. A user can see and use the shared resources from other users.

Once the account and VM template have created, the author can now login into this page by using username and password created by the *oneadmin* as shown in the figure below.

Figure 12: *OpenNebula Login Page*

After login into the web page, the author was able to see a VM template that have been created. A template file consists of a set of attributes that defines a VM. Similar like a real computer system, a VM within the OpenNebula system consists of a capacity in terms of CPU and memory, a set of one or more virtual networks, a set of hard disk space, and a set of OS system. Figures below shows the template and system properties of the VM created.

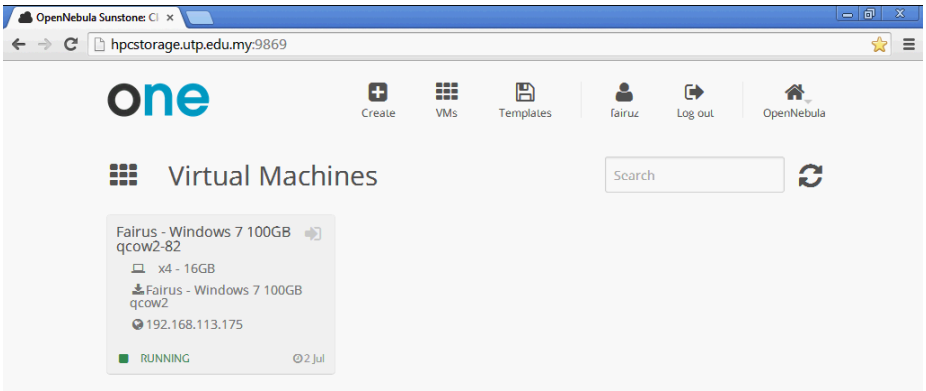


Figure 13: *Virtual Machine Template created on OpenNebula*

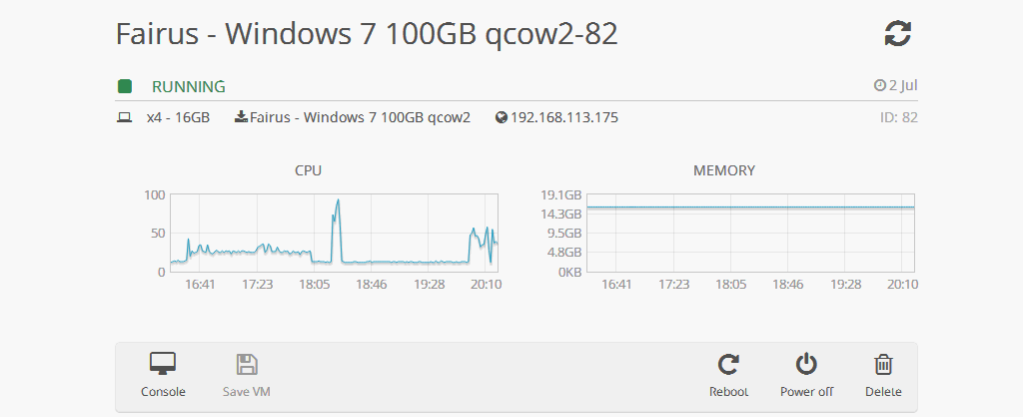


Figure 14: *The System Properties of Virtual Machine*

As shown in the figure above, there are ways to terminate, temporarily stop or resetting a running VM. First, if the user need to terminate when the VM is not responding to other actions, use *Delete* and the VM will immediately destroyed. Second, if the user need to temporarily stop the execution of a VM in the short term pause, use *Power off* and it will gracefully powers off a running VM. Third, if the user need to resetting a running VM, use *Reboot* and it will gracefully reboots a running VM.

4.1.5 Experiment Setup

In this section, the author will elaborate the details of the experiment setup in this project from the steps of creating virtual machines until installing the open source SVP which is OpendTect.

a) Creating Virtual Machines

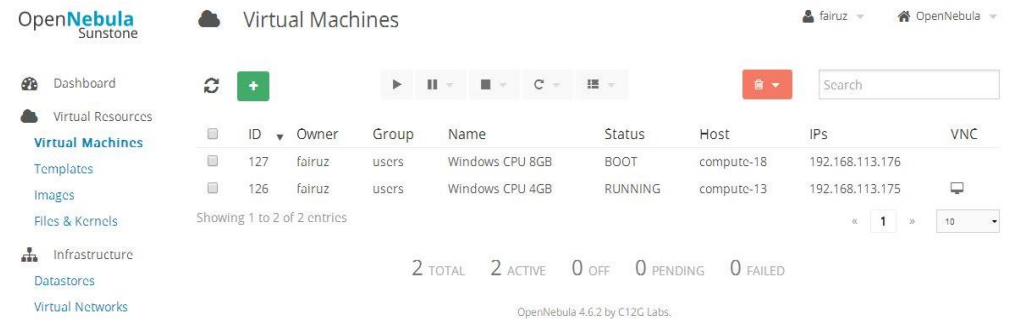


Figure 15: *Two System of Virtual Machines*

Figure 15 shows two example of virtual machines that have been created with different specification of Central Processing Unit (CPU) in order to compare the execution time performance of open source SVP when running on VM. In general, CPU is the brains of the computer where most calculations take place and in terms of computing power, it is the most important element of a computer element. The CPU for the VM is limited up to 8GB. Table 6 shows the two example of system attribute out of the five VMs created.

VIRTUAL MACHINES	NAME	OS SYSTEM	MEMORY	CPU	HARD DISK SPACE
VM 1	Windows CPU 4GB	Windows 7 qcow2	16GB	4GB	100GB
VM 2	Windows CPU 8GB	Windows 7 qcow2	16GB	8GB	100GB

Table 6: *The System Attributes of Virtual Machines*

b) Accessing Virtual Machines by using TeamViewer

TeamViewer is an open source software that lets the user to fully control of another computer from their own computer as long as both machines are running TeamViewer. In this project, the author use TeamViewer to remotely control the VM that have been created earlier. It enables two-way connections in which the author can get control of the VM just as if the author were sitting in front of the VM. The process to download and install this program is very simple. The following are facts to be followed during accessing VM using TeamViewer:

1. Go to the TeamViewer website and download the latest version of TeamViewer. Once the file is downloaded and installed, the next screen is the TeamViewer Screen.

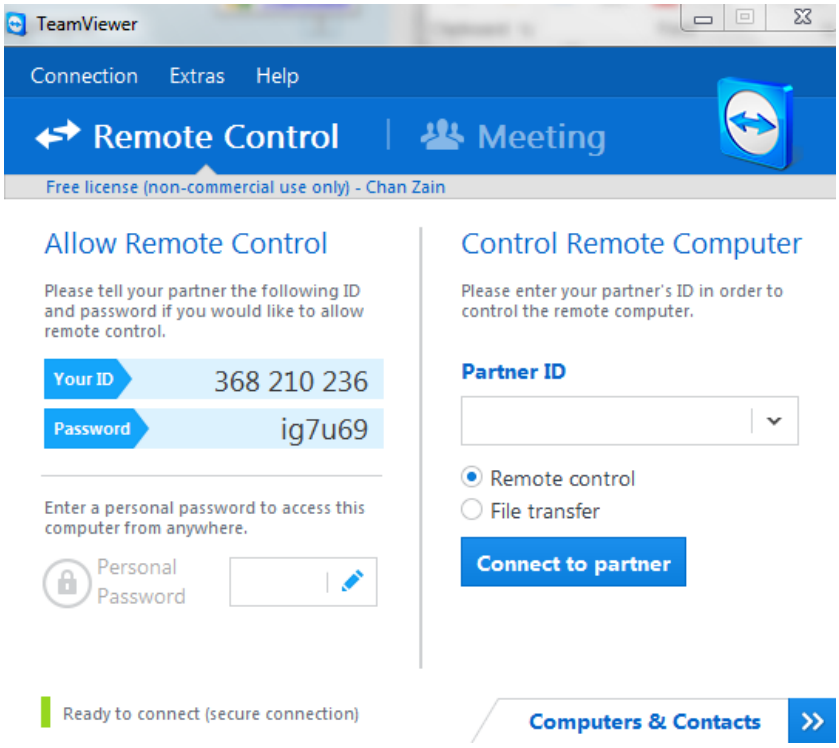


Figure 16: *TeamViewer Login Page*

2. To use TeamViewer, the author require an ID number of VM in order to connect to the VM. The author needs to enter the ID number into the partner ID field and then select Connect to partner. The author will also require a password to access the VM. The required ID and password to access VM 1 and VM 2 are as stated below:

Virtual Machines	ID	Password
VM 1	474211516	passwordvm1
VM 2	656262910	passwordvm2

Table 7: *The Virtual Machines' ID and Password*

3. Once accessed author can work on that VM from author's desktop.

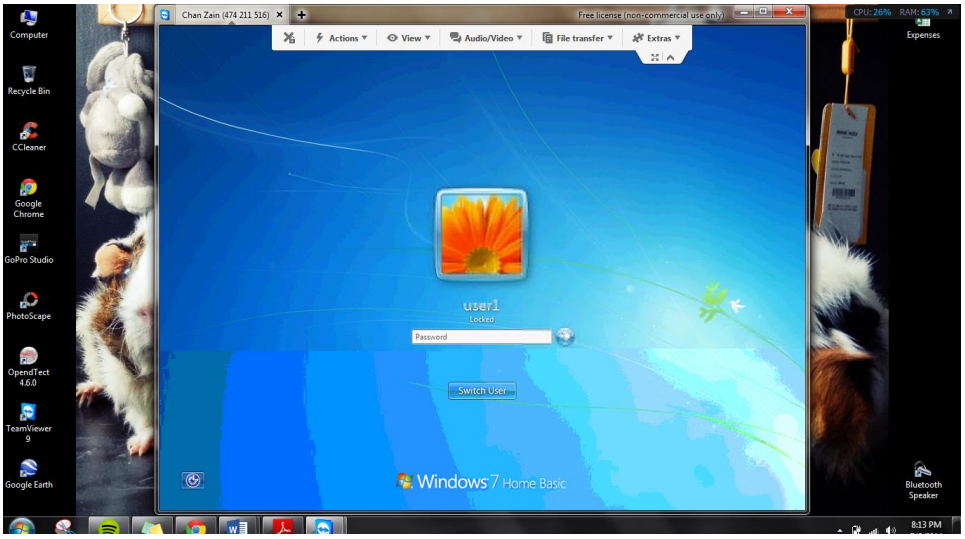


Figure 17: *Connected to VM from author's desktop*

c) Installation of OpendTect on VM

Similar as TeamViewer, OpendTect is also an open source software and thus the process to download and install this program is very simple. However, for addition of commercial plugins it may require extra actions. The following are facts to be followed during installation of OpendTect on VM:

1. By using VM, go to OpendTect website and download the latest version of OpendTect. Once the file is downloaded, execute the OpendTect installer.

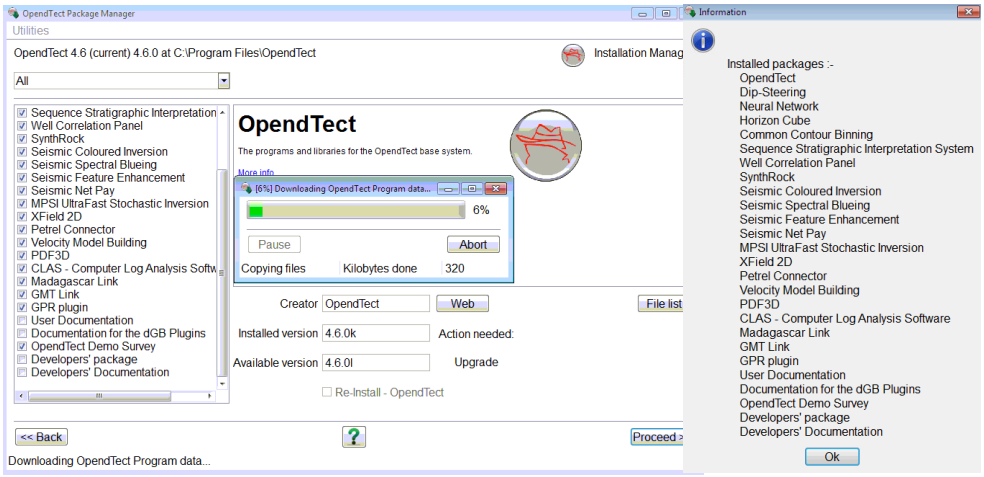


Figure 18: *Installing the OpendTect*

2. Once the program is installed, an auto-loaded plugins will pop up and select any possible plugins that will be use during seismic survey. However, it is preferable to select all plugins to be loaded before start a seismic survey.

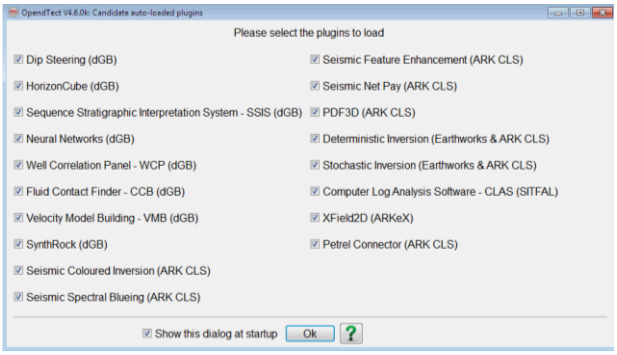


Figure 19: *OpendTect Plugins*

3. Now the program is completely installed and ready to create or setup a seismic survey. However, a seismic survey data is needed in order to analyze seismic survey for visualization and interpretation.

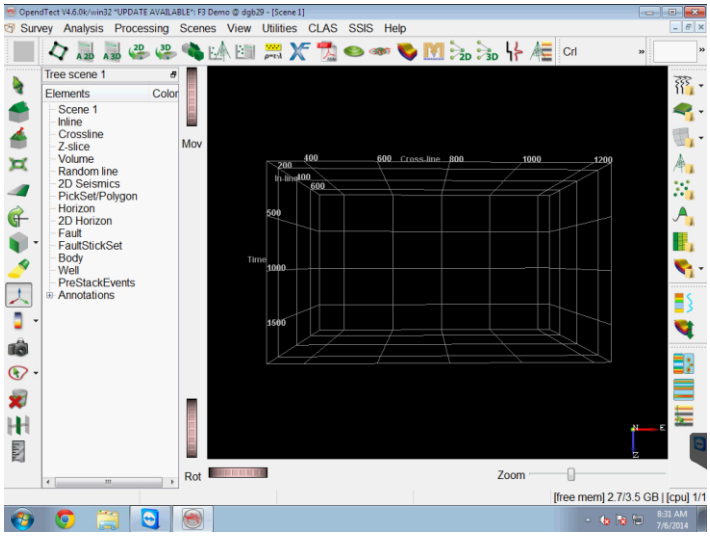


Figure 20: *OpendTect Survey Screen*

4. In this case, since the seismic survey data is located in the author's desktop, TeamViewer is used to transfer the seismic data files to the VM. After the data files are completely transferred, the performance loading speed of the seismic survey is ready to be tested.

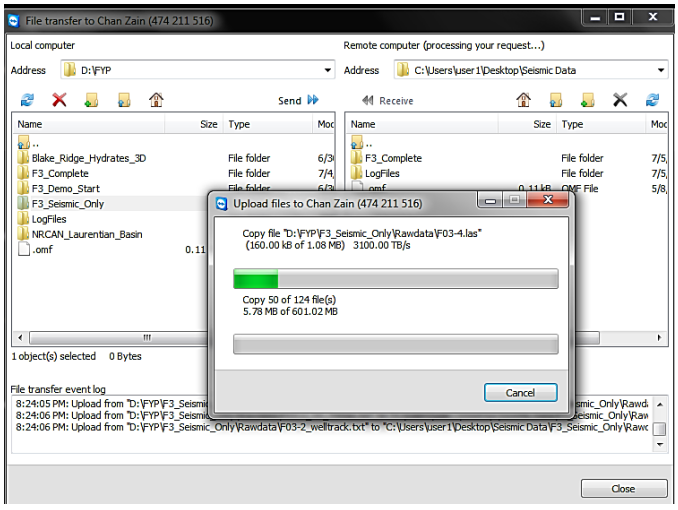


Figure 21*: Transferring Seismic Survey Data*

d) Seismic Survey Data

There are different ways to get the seismic survey data. First, there are free and public seismic data sets that are available for download in OpendTect website. They believe that by sharing the data it is beneficial for the entire seismic community. Second, the seismic data can be obtain from companies or personal.

For this project the author has received several set of seismic survey data from the supervisor. The survey testing have been developed by using a seismic survey data from Netherlands Offshore F3 Block. F3 is a block located in the Dutch sector of the North Sea. The first well was to be drilled in 1987. The seismic data consists of 3D seismic data, horizon, and wells.

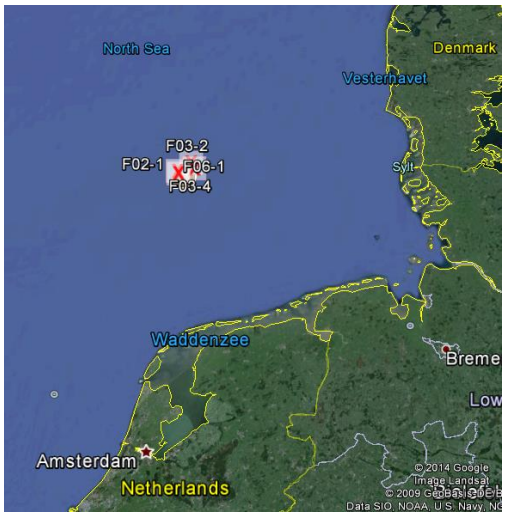


Figure 22: *Location of F3 Block using Google Earth*

The original F3 dataset is rather noisy. Therefore, in order to improve the survey, there are a few 3D seismic data that are included in the package to be apply. For example, a dip-steered median filter can be apply to the data to remove the noise. In addition, there are four vertical wells that present in this survey and all wells had gamma ray log and sonic log. The size of the seismic data is 6.36 GB. The following is the list of available data that are included in the F3 Block complete packages:

SEISMIC DATA	HORIZONS	WELLS AND LOGS
▪ 1_Original_Seismic.cbvs ▪ 2_Steering_BG_Detailed.cbvs ▪ 3_Steering_BG_Background.cbvs ▪ 4_Dip_steered_median_filter.cbvs ▪ 5_ChimneyCube.cbvs ▪ 6_Wheeler-stratal-slicing.cbvs ▪ 7_AI_Cube.cbvs ▪ 8_PorosityCube.cbvs ▪ 9_Similarity_on_Original_seismic.cbvs ▪ 9–1_Similarity_on_FEF_seismic.cbvs ▪ 9–2_Dip-steered_diffusion_filter.cbvs ▪ 9–3_Fault_enhancement_filter.cbvs ▪ 9–7_Thickness_UVQ6_segment_slice520.cbvs ▪ 9–8_UVQ6_Hor_4–8_segment.cbvs ▪ 9–92_2D_SSIS.cbvs ▪ 9–92_2D_SSIS^01.cbvs ▪ 9–92_2D_SSIS.2ds ▪ Velocity_model__INT_.cbvs ▪ Velocity_model__RMS_.cbvs	▪ Demo0 (FS4) ▪ Demo1 (MFS4) ▪ Demo2 (FS6) ▪ Demo3 (Top_Foresets) ▪ Demo4 (Truncation) ▪ Demo5 (FS7) ▪ Demo6 (FS8) ▪ Demo7 (Shallow)	▪ F02–1 (Caliper, Density, GR, P-Wave, Porosity) ▪ F03–2 (Density, GR, P-Wave, Porosity) ▪ F03–4 (Density, GR, P-Wave, Porosity) ▪ F06–1 (Density, GR, P-Wave, Porosity)

Table 8: *The Available Data in Seismic Survey of F3 Block*

4.1.6 Experiment Assessment Method

In this section, all the five VMs will use the same assessment method. A seismic survey testing was conducted in order to see the performance of OpendTect to interpret the seismic survey on the VM. Even though the installation of OpendTect on VM is successful, it is better for the author to conduct this testing in order to evaluate the quality performance of OpendTect on VM when performing a seismic survey.

- **Start a Seismic Survey**

The OpendTect surveys are organized under survey selection window which is used to create, remove, or edit the survey(s). A survey defines the geographical boundaries of an OpendTect project and relevant positioning information such as the relationship between inline/crossline and X/Y co-ordinate systems. The rotation angle of the survey is also displayed to shows the deviation from geographic North. The following are facts to be followed to start a basic seismic survey in OpendTect:

1. The survey selection window is launched from **Survey** (menu) > **Select/Setup** or select survey icon  .

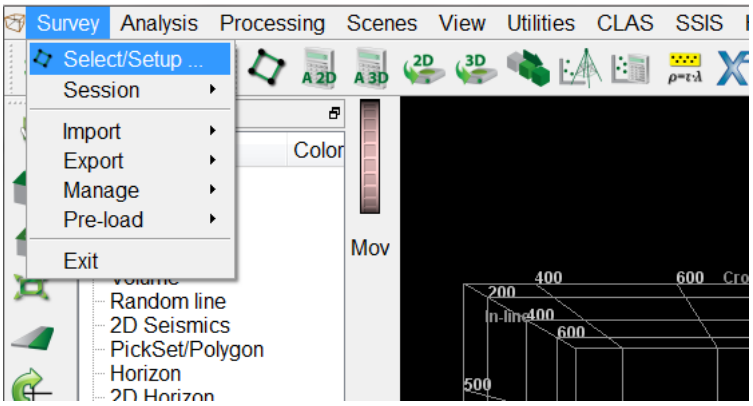


Figure 23: *Survey Menu*

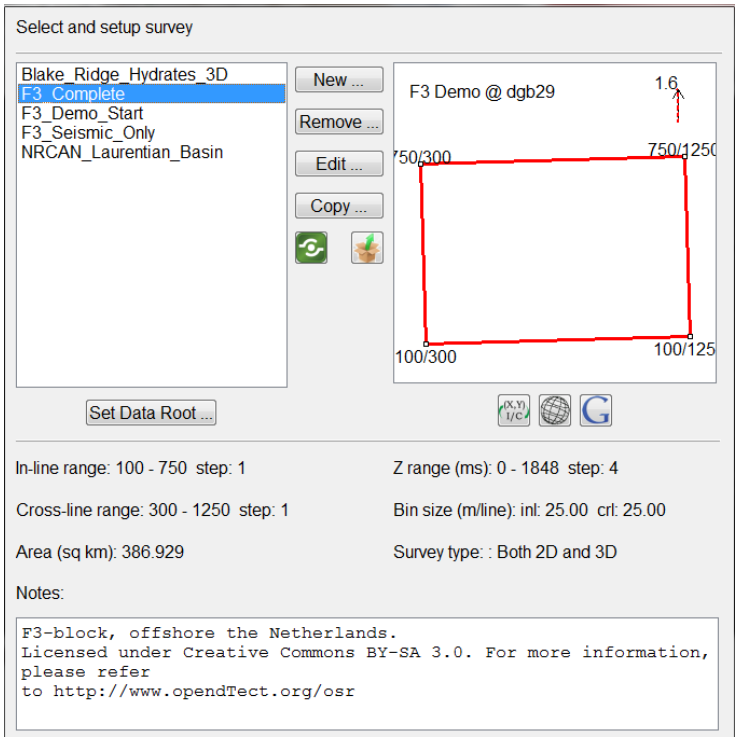


Figure 24: *Survey Selection Window*

2. For this project, the author use an existing survey from the list of surveys on the left where in this case "F3_Complete" is selected. The parameters use for this survey are as follows:

Inline Range	100	750	step 1
Crossline Range	300	1250	step 1
Z Range (ms)	0	1848	step 4
Bin Size (m/line)	inl: 25	crl: 25	
Area (sq.km)	386.929		
Survey type	both 2D and 3D		

Table 9*: Survey Parameters*

3. Once the survey is setup, a set of data from the existing survey will be loaded. In order to display the loaded seismic data, use a mouse to click inline/crossline and select the *Add* sub menu from the column *Tree*.

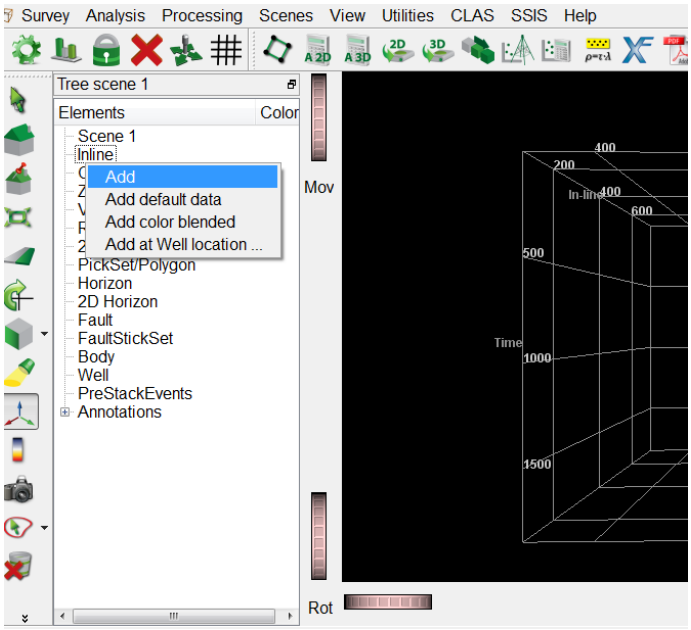


Figure 25: *Adding Seismic Attribute*

4. A seismic line will be displayed in the middle of a survey that will contain a blank attribute.

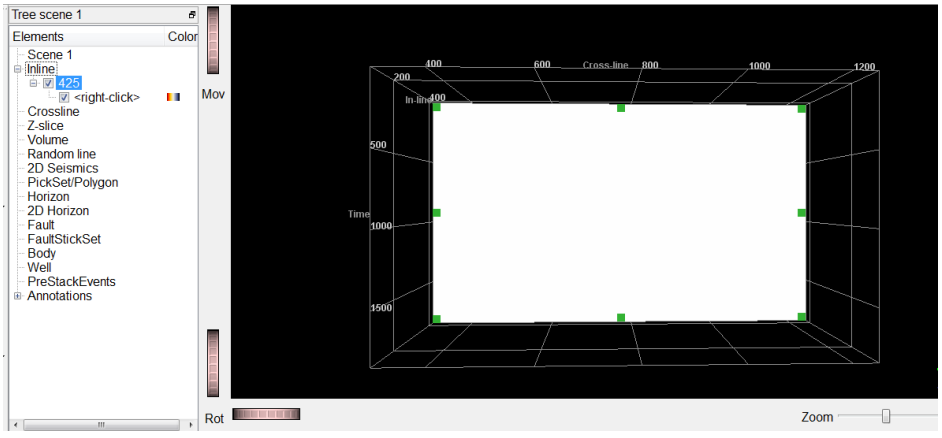


Figure 26: *Survey with Blank Attribute*

5. Right click on the attribute to select and display the loaded data.

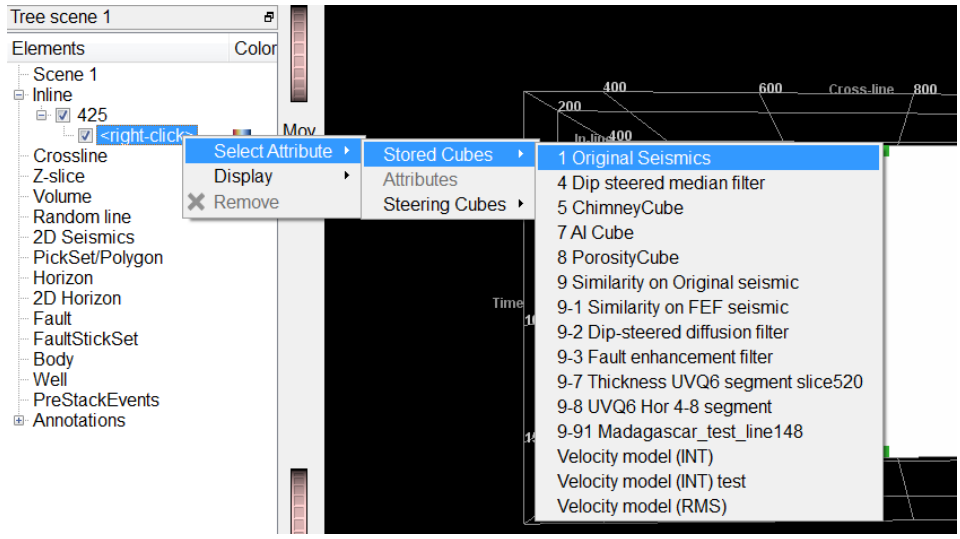


***Figure 27**: Selecting Seismic Attribute*

6. The seismic data with original seismic attribute will be displayed.

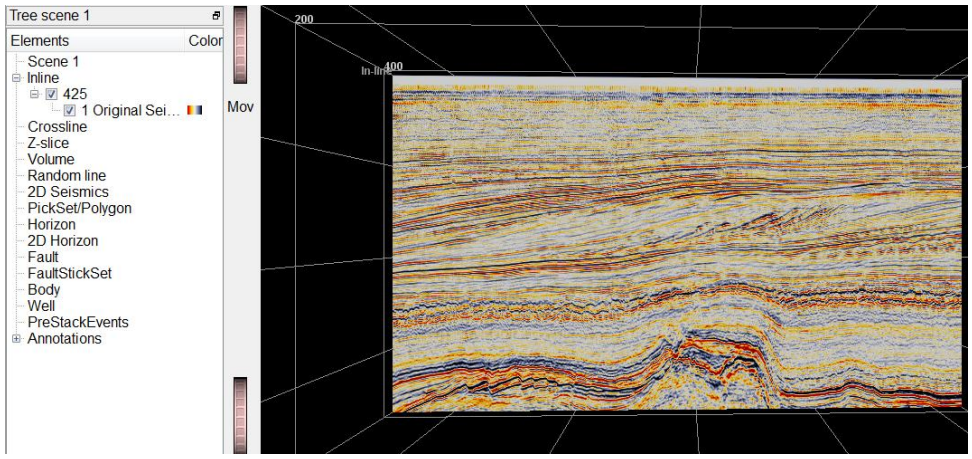


***Figure 28**: Survey with Seismic Attribute*

- **Load Seismic Attribute**

The purpose of seismic attribute is to improve the original seismic data since usually the original data is rather noise. OpendTect contains several menus, icons and toolbars. One of the most important toolbox is the attribute set window contains a set of seismic attributes definitions to be evaluated. The following are facts to be followed to load one of the attribute sets which is dip-steered median filter in order to develop a smooth and less noise seismic data.

1. Load and use the seismic survey as shown in the previous section.

2. The default attribute sets is launched from **Analysis** (menu) > **Attribute** > **3D** or select analysis 3D icon 

. Then select this icon  to open default attribute sets as shows in the figure below.

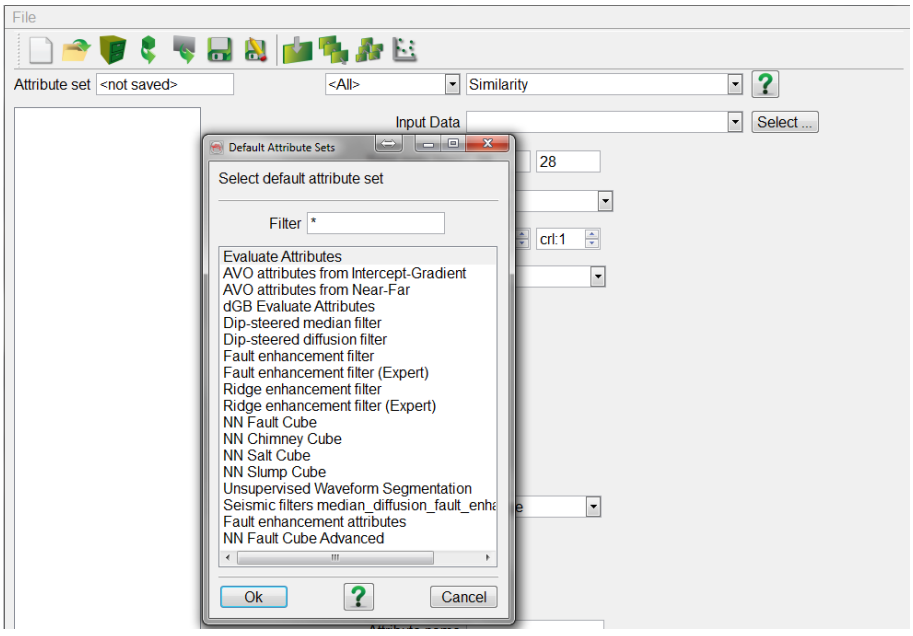


Figure 29: *Default attribute sets window containing the list of all available default attributes*

3. Select Dip-steered median filter and a window will pop up and select the input seismic and a steering as shown in the figure below.

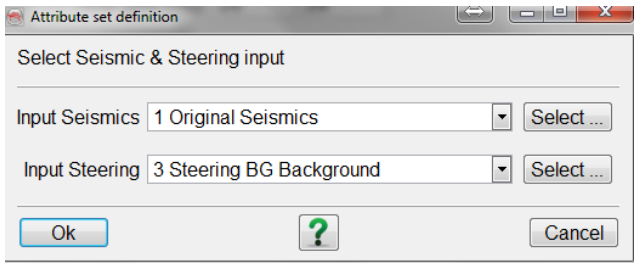


Figure 30: *Attribute Set Definition*

4. Select icon in the circle as shown the figure below to redisplay the element with current attribute that already setup.

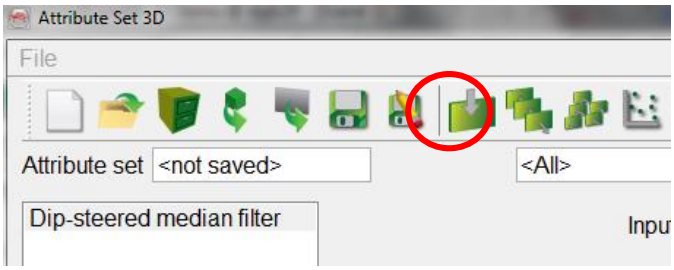


Figure 31: *Redisplay the attribute*

5. Now after the attribute is applied, the seismic data has been cleaned up from random noise and more clear data can be observed.

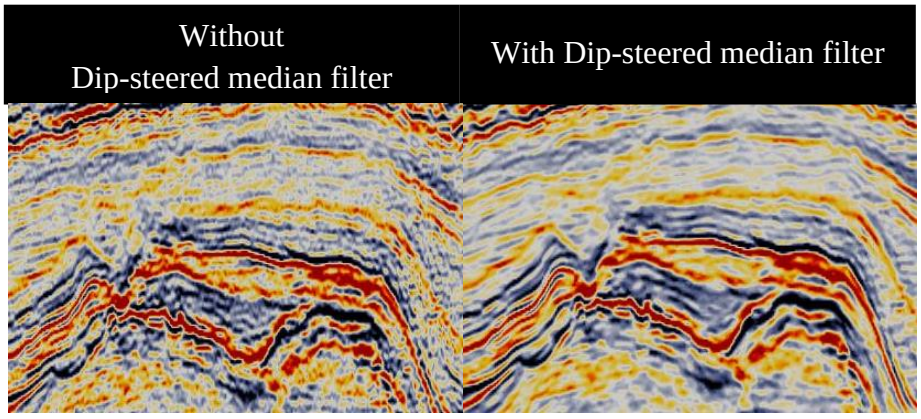


Figure 32: *Effect of Dip-Steered Median Filter*

4.1.7 Experiment Result

Based on the comparison between five virtual machines created, the scalability performance of open source SVP on OpenNebula cloud can be observed. Table 9 shows the performance result of execution time from each virtual machine with different CPU capacity.

VIRTUAL MACHINES	VM 1	VM 2	VM 3	VM 4	VM 5
CPU	1GB	2GB	4GB	6GB	8GB
Memory	16GB	16GB	16GB	16GB	16GB
Execution Time	15s	8.5s	4s	2.4s	2s

Table 10: *The Execution Time of Virtual Machines*

Figure 34 shows that the more CPU capacity, the faster the execution time. Thus, it can be conclude that, the more CPU can reduce the time needed to execute the program.

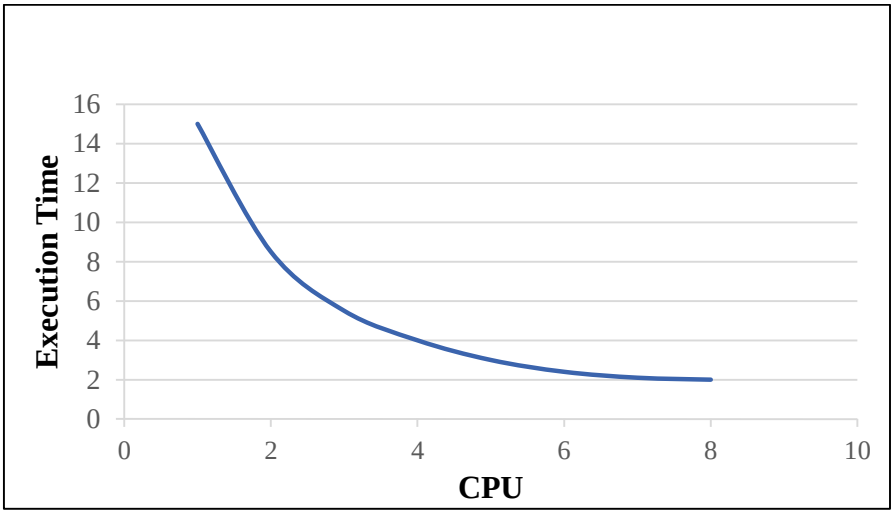


Figure 33: *The Relationship of Execution Time and CPU*

Based on the relationship between execution time and CPU capacity, the speedup of the system can be calculated. Speedup can be used to show the effect of any performance enhancement.

VIRTUAL MACHINES	VM 1	VM 2	VM 3	VM 4	VM 5
CPU	1GB	2GB	4GB	6GB	8GB
Execution Time	15s	8.5s	4s	2.4s	2s
Speedup	1	1.8	3.8	6.3	7.5

Table 11: *The Speedup of Virtual Machines*

The author execute the program on the VM1, which yields an execution time of 15 seconds. Next, the author execute the program with modified CPU (VM2), which produced an execution time of 8.5 seconds. By using the speedup formula,

$$Speedup = \frac{T_{old}}{T_{new}} = \frac{15\ s}{8.5\ s} = 1.8$$

The performance enhancement can be calculated, where T_{old} is the old execution time without the improvement. Meanwhile, T_{new} is the new execution time with the improvement. Figure 35 shows that the more CPU, the higher the speedup. This shows that, the open source SVP is scalable to give higher performance.

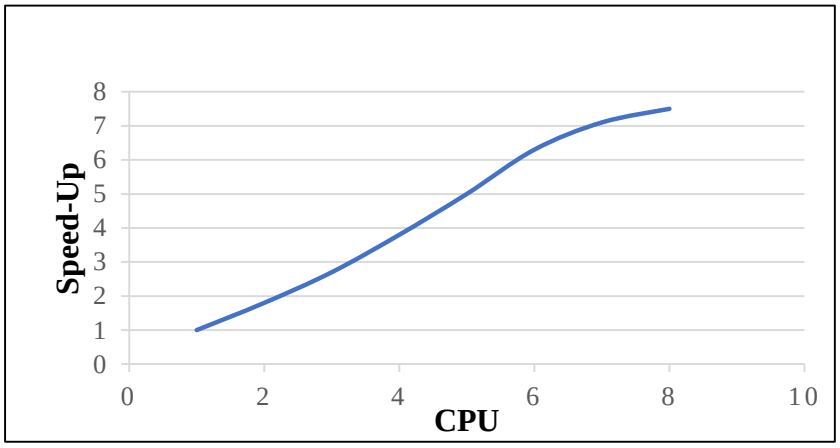


Figure 34: *The Relationship of Speedup and CPU*

4.2 Discussion

4.2.1 Problem and Difficulties Encountered

There are many problems and difficulties encountered during the execution of the research, development of Virtual Machine (VM) application, and development of the guidelines. Each phase contributes to different sets of problems.

During conducting the research part of the project, problems such as limited information regarding the use of open source SVP in the field of VM, the application of OpendTect in current oil and gas industry were encountered. The limited duration of time to carry out more comprehensive research were also encountered. Thus, these problems result in less information obtained and the project only proceed with the available information.

However to overcome this problem, the extensive use of articles in the Internet is required. Even though some information in the Internet cannot be fully trusted, therefore the background of each author needs to be identified.

The problem face in developing the VM application is to understand the concept of the system architecture. Due to limited knowledge in using the OpenNebula cloud management system and limited time constraints to learn, not all facts in the VM are listed in the guideline, especially the area that needs coding of interaction in creating the VM.

To overcome this problem, a fast pace learning method especially in the IT and programming part need to be done. For example, the codes use to create VM in OpenNebula are done by the staff in UTP HPC center. A reference and discussion with a knowledgeable and experienced person regarding OpenNebula and TeamViewer tool are required.

Another problem face in developing the VM application is the unstable network and server. Due to the low signal strength of network connection, the performance speed of OpendTect in VM are lagging and not smooth. Also, due to the sudden shutdown of the server cause by power trip, the ID and password to connect to VM using TeamViewer always keep changing.

As a solution to these problems, it is preferable to run the program at the area that have high signal strength of network connection. For example, in academic block and HPC center which have more stable network connection compared to student hostel. Next, to overcome the problem of ID and password that keep changing, the author used a static password to connect to the VM. This password will not change when VM experienced sudden shutdown.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

5.1.1 Impact

Basically all the system is completed and functioning very well. Until now the author has successfully meet her objectives. Based on the objectives of this project, three (3) conclusions have been made. The conclusions are as followed:

1) Based on the comparative study between two different types of open source OpendTect and ParaViewGeo in Chapter 4.1, it has been concluded that the preferable open source SVP to be used in this project is OpendTect. The main reason is because OpendTect provides more details on the seismic attribute and filters. OpendTect also provides more computational functionality requirement compared to ParaViewGeo. Thus, OpendTect possesses more functionality to be the preferable open source SVP.

2) Based on the experiment setup in Chapter 4.1, it shows that OpendTect can be successfully installed and configured on VMs where the VMs run on OpenNebula cloud. It has strongly proved that the experiment have been successfully executed without any system error. This shows that the second objective of this project is successfully achieved.

3) Based on the experiment result from Chapter 4.1, it is proved that OpendTect can be executed on the OpenNebula cloud with high scalability and good performance. It can be concluded that the more CPU, the faster the execution time and the speedup. Thus better performance can be achieved.

5.2 Recommendations

Due to limited duration of time available, there is a constraint to produce an effective of research and the author may not fulfill certain important requirement which can be improve in the future. Therefore, for the future enhancement of this system, several recommendations can be made with a sufficient time given. Potential recommendations are listed below:

5.2.1 Improve network connection

Although the network connection is unpredictable, but if the author was able to improve it in the future, the system maybe can be implemented in areas that have very strong signal network connection such as in HPC without network sharing with other places.

5.2.2 Conduct a further test on system

In order to get consistent and accurate result, further testing on the system is recommended. This test would have similar procedure as conducted earlier. The goal of this test is to find as many problems that are still occurring in the VM application even though the procedure in the guidelines are followed.

5.2.3 Development of VM application

In order for large application such as OpendTect to improve in term of quality and performance, a large capacity of VM should be developed. A small

application is easy to perform in VM, but to adapt in a large application is still an area to be improve.

5.2.4 Implement of OpendTect

Although the OpendTect is an open source software, the popularity still not encouraging. It will be more advance if the author able to promote this software to university especially in Petroleum department since this software have academic license where universities can get free access to both non-commercial and commercial OpendTect plugins.

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APPENDIX

Basic Step

How to Use OpenNebula

Login Page

The first page after you accessed to OpenNebula Sunstone at http://192.168.113.214:9869/

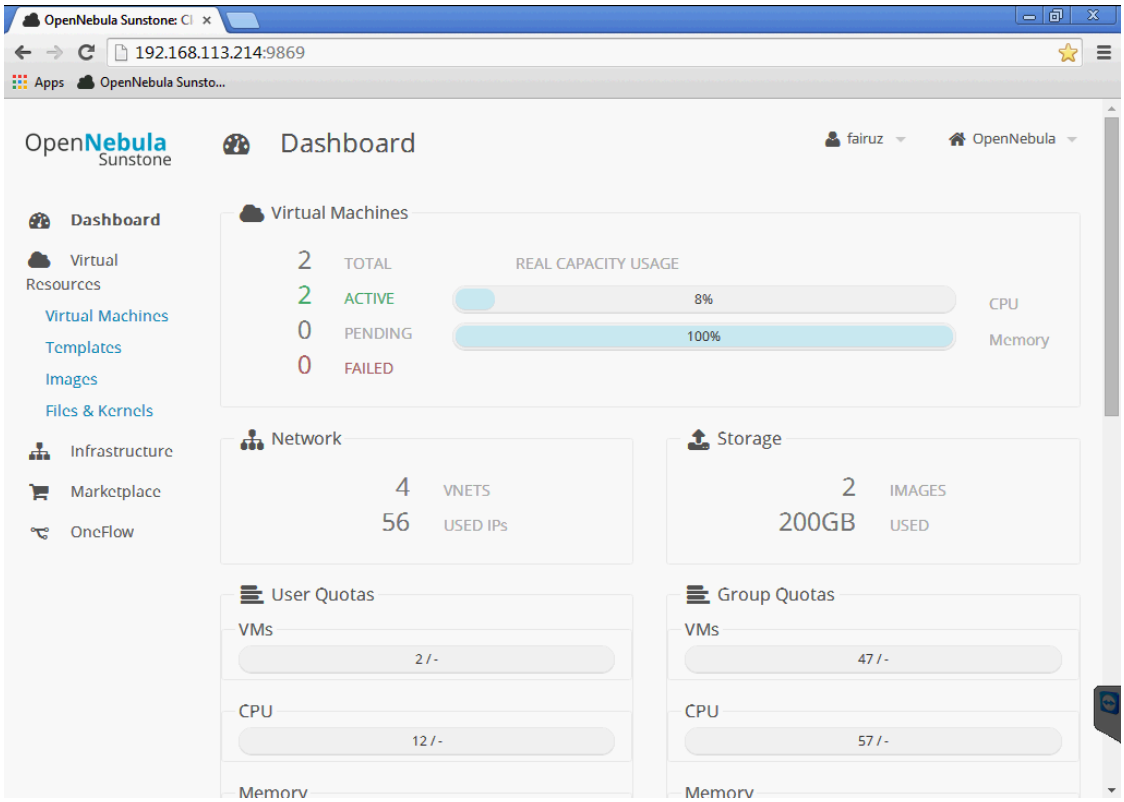
Here you can login by using your Username and Password.

[Note: Please contact the administer to create a new account in case you still do not an accout]

Dashboard

This is your dashboard.

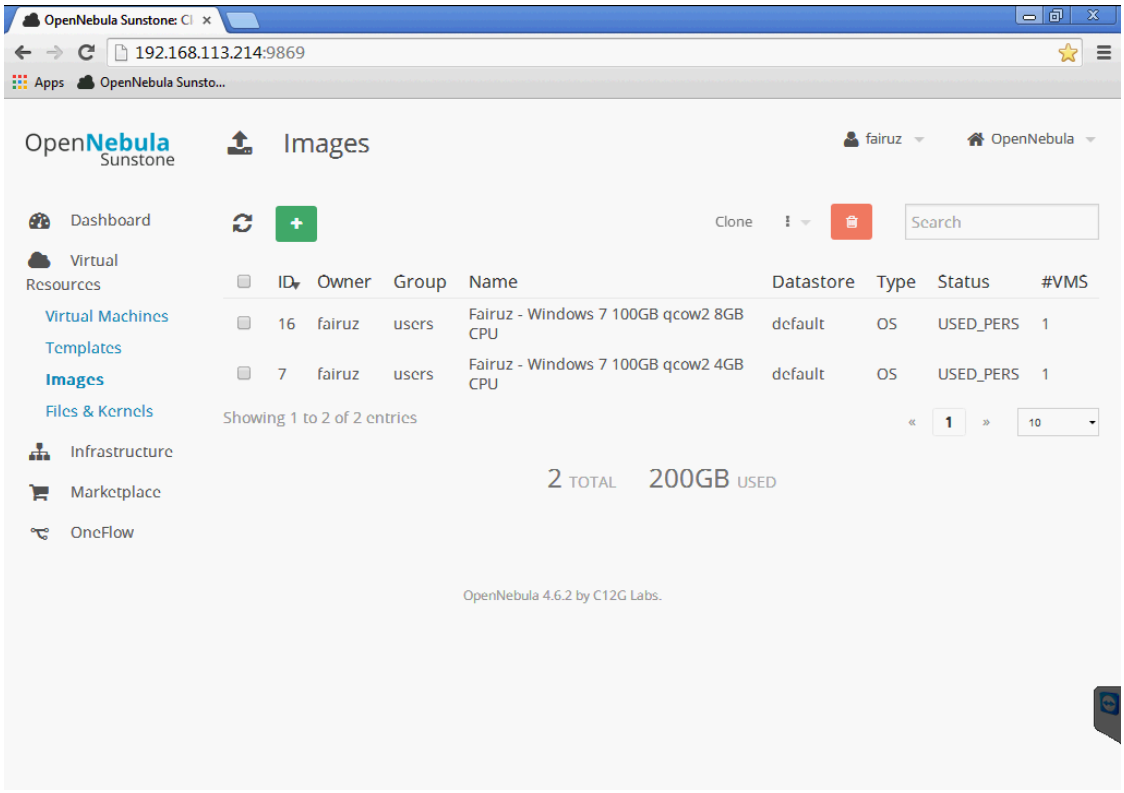
This page shows the overall virtual machines that you have used.



Images

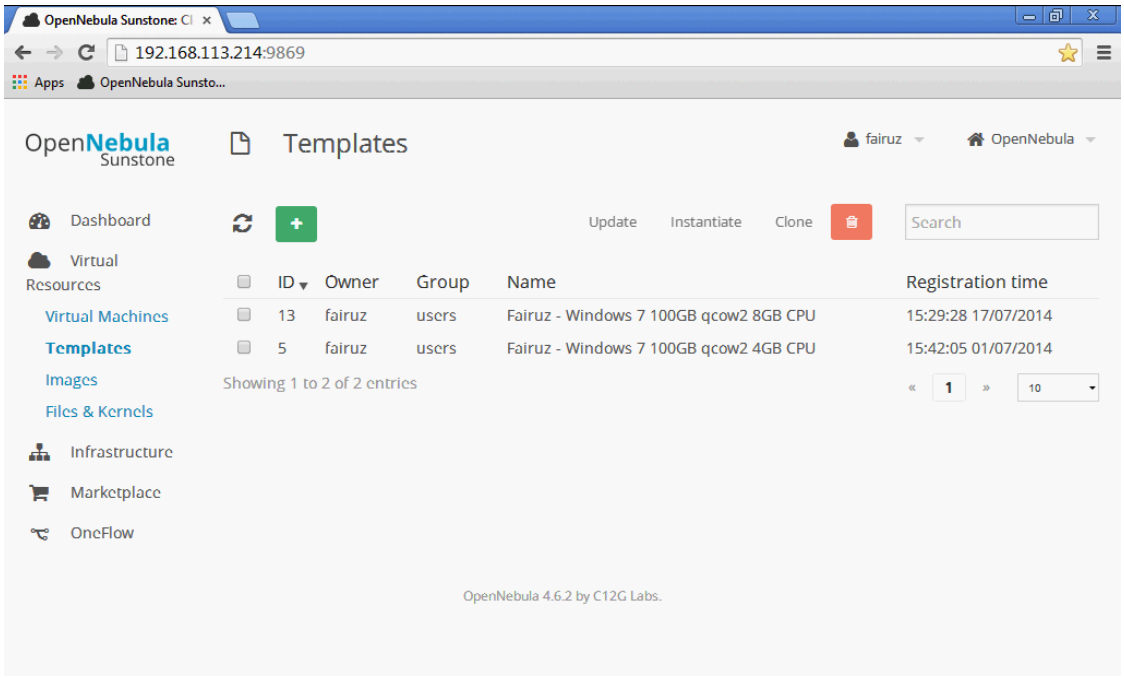
This is a section where it shows you all the image that you own.

[Note: You can either create your own image or ask from the administrator]



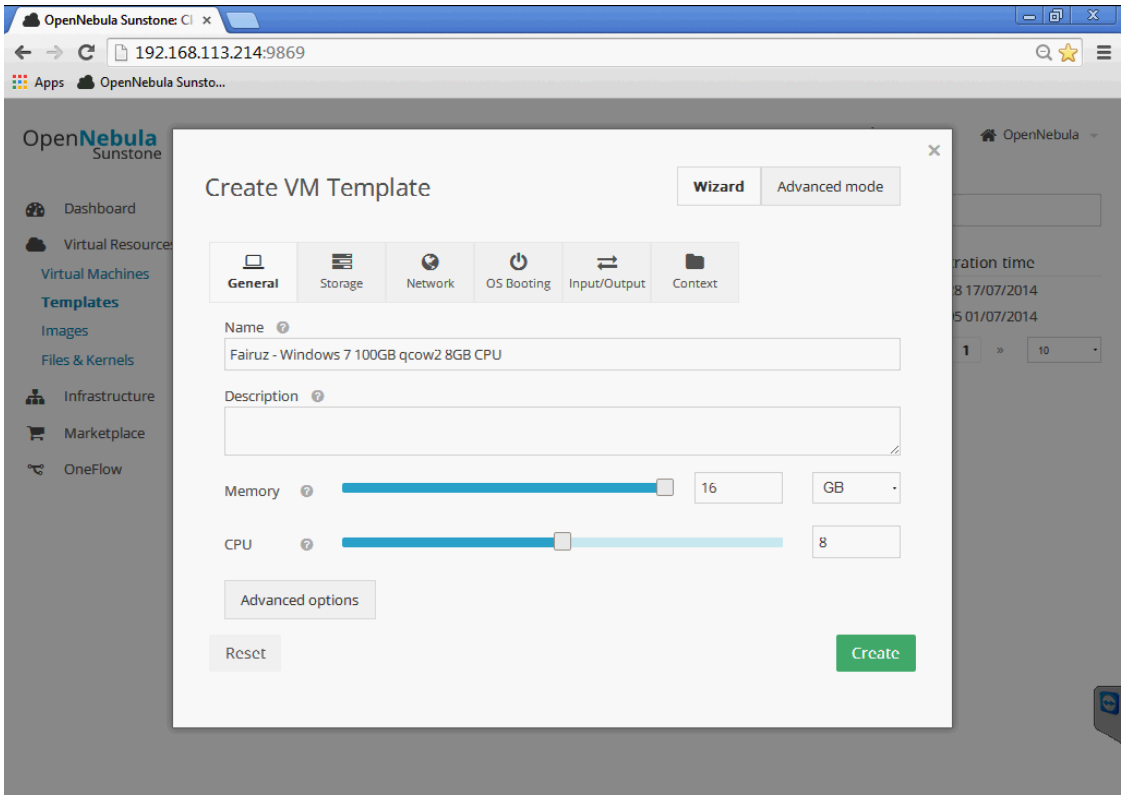
Template

This is a section where you can create your template. In easy word, template is like your PC specification (CPU, RAM, and NIC), while your image is your HDD.

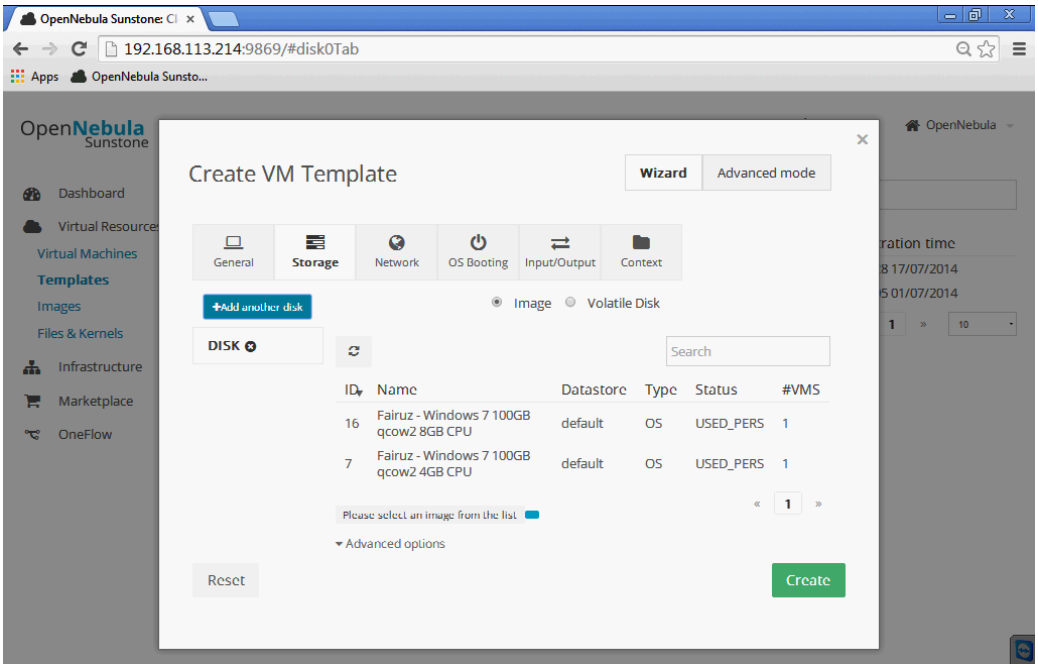


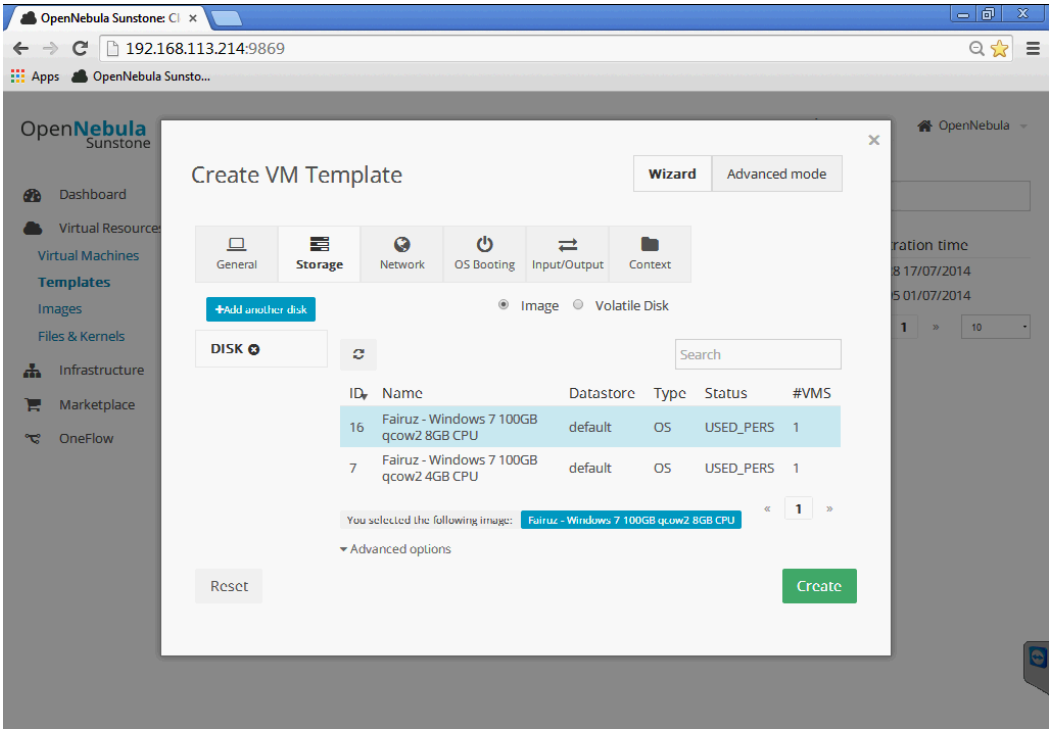
Steps to create a Template

1. First, click the green button, then a new windows pop out.
2. In **General Tab**, you must specify:
    i. The name of your template.
    ii. The memory is in GigaByte [Note: In this project, the VM is assigned 16GB of memory]
    iii. The CPU for the VM [Note: It is limited based on the host. In this project, the host has up until 8GB core processor. 8GB is actually 8 Core.



3. In **Storage Tab**, you just click the image that will be used as the “HDD” that already contained an OS.



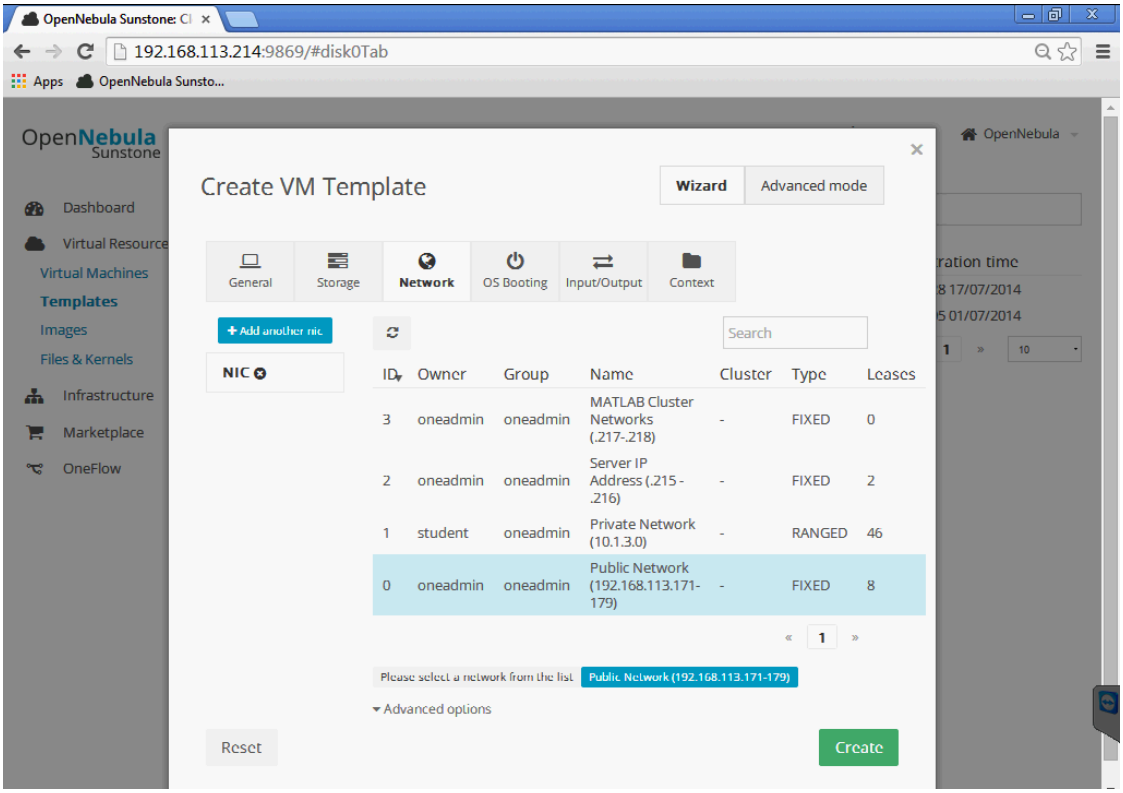


After you click on the image, you can see the sentence change from “Please select…” to “You selected…”, and you are fine to go.

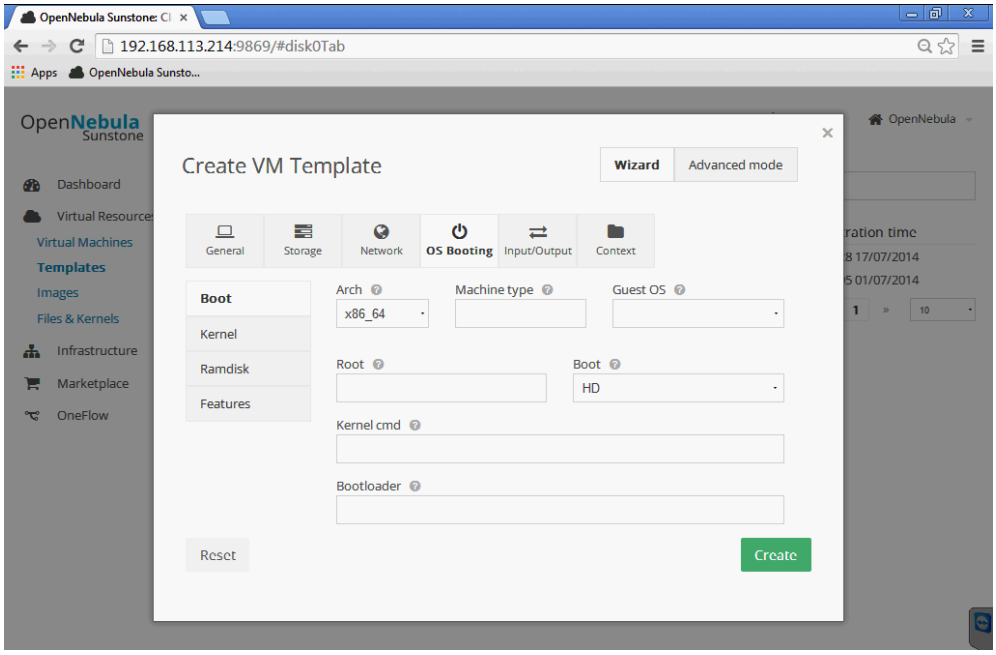
4. In **Network Tab**, you can select your Network.

   [Note: Usually the Network is created by the administrator and it is shared for all user]

   [Note: For security purposes, you can create a new Network and ask the administrator for the IP addresses that are free]

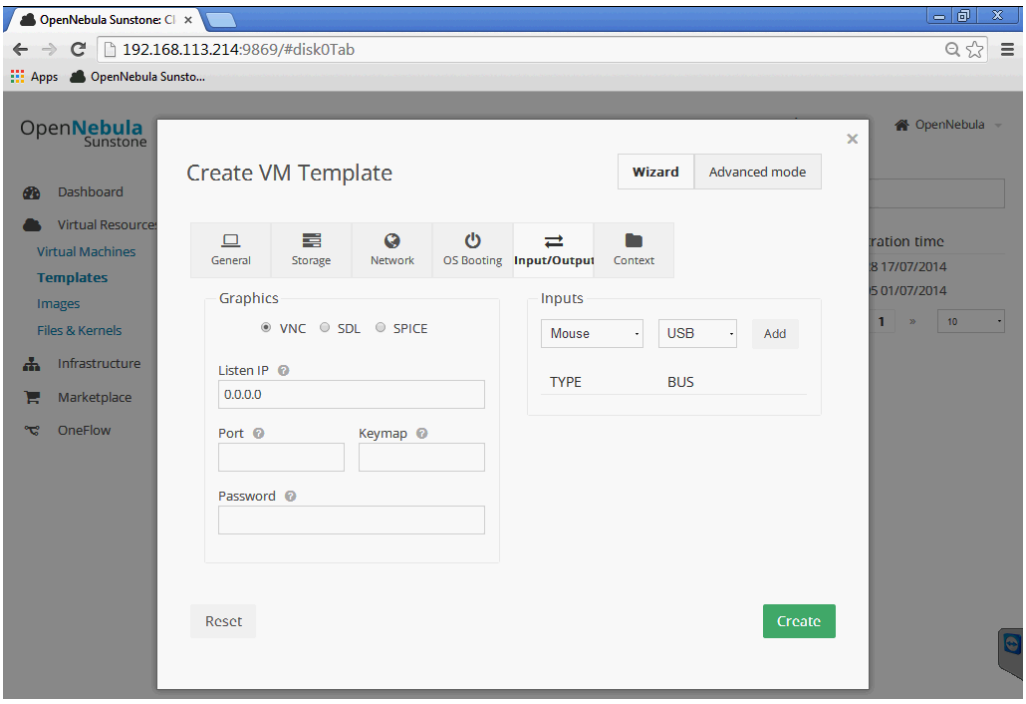


5. In **OS Booting Tab**, you just specify 2 options:
   i. Arch – i686 (If your OS is 32-bit) or x86_64 (if your OS is 64-bit)
   ii. Boot – HD (Boot form HDD) or CDROM (Boot form CD Drive)



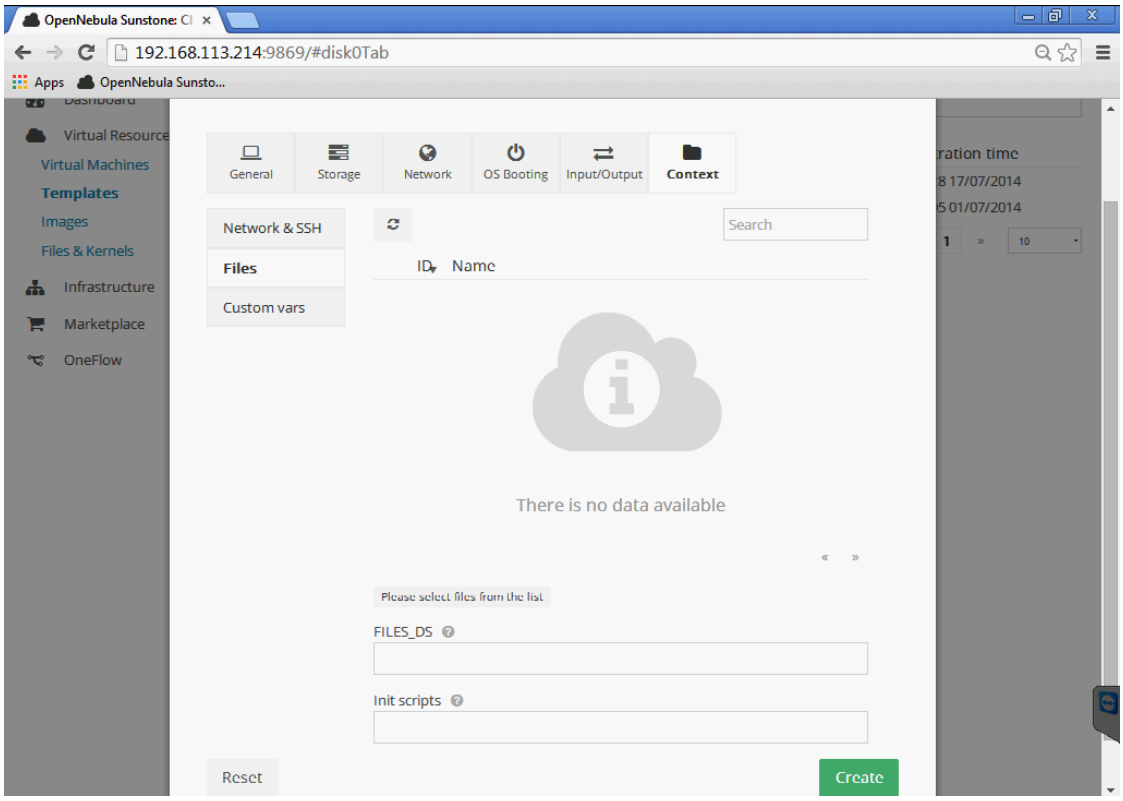
6. In **Input/Output Tab**, you must chose a Graphics and an Inputs.

   [Note: You can choose either use VMC or SPICE. In this project VNC is used.]



7. In **Context Tab**, it is OPTIONAL.

   If you have any files to be included with your VM, you can click on “Files” Tab



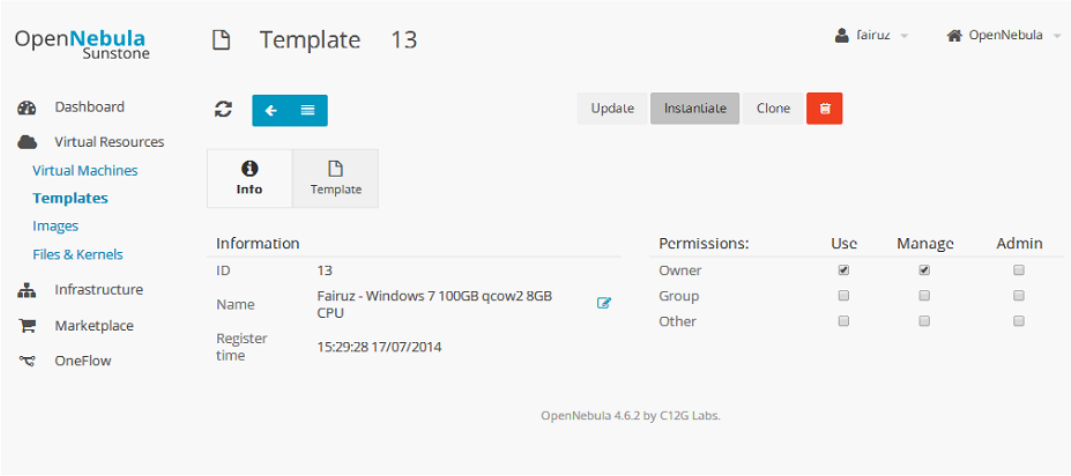
8. Finally, you just click on CREATE and you can see your template have been created.

Virtual Machine

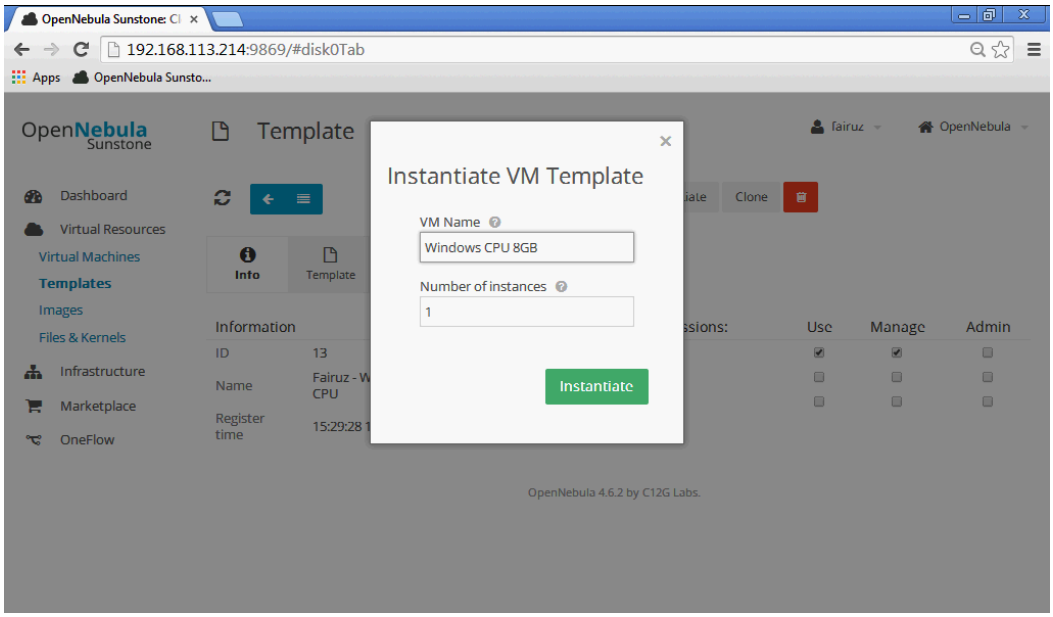
This is a section where you can create or deploy or instantiate your Virtual Machine (VM)

Steps to create a VM

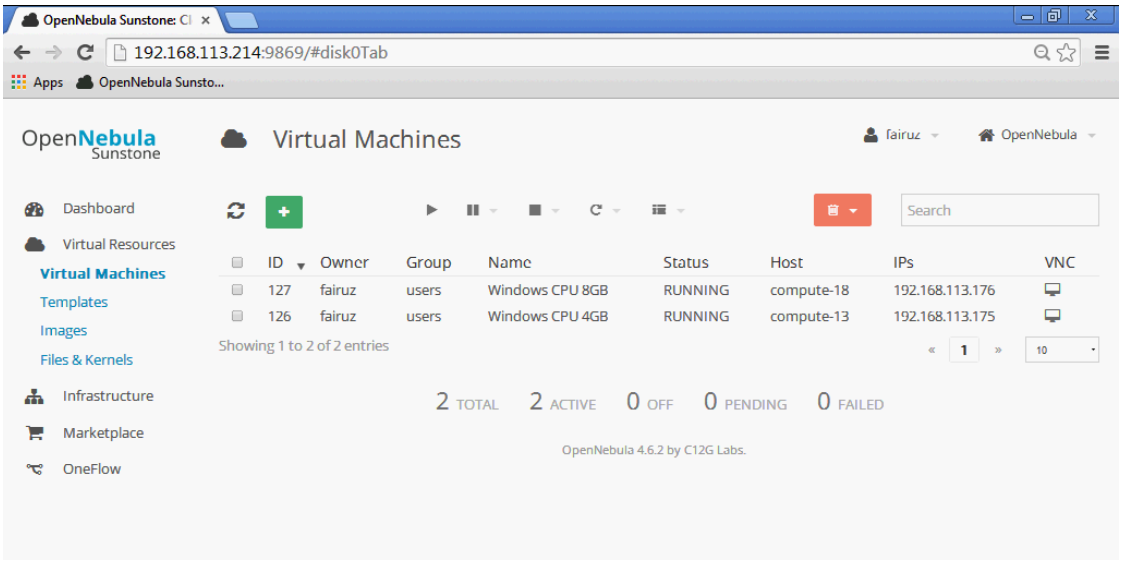
1. First you select your template and click the “Instantiate” button and a new windows will pop out.



2. Enter your preferred VM name and click “Instantiate” green button.



3. Select Virtual Machine Tab under Virtual Resources Tab to see your VM.
   [Note: Your VM status will shows “PENDING > PROLOG > BOOT > RUNNING”]



4. You have successfully instantiate a VM (Running).